RAILROAD GAZETTE

ESTABLISHED IN APRIL, 1856.

PUBLISHED EVERY FRIDAY BY THE RAILROAD GAZETTE AT 83 FULTON STREET, NEW YORK
BRANCH OFFICES AT 375 OLD COLONY BUILDING, CHICAGO, AND QUEEN ANNE'S CHAMBERS, WESTMINSTER, LONDON

EDITORIAL ANNOUNCEMENTS.

THE BRITISH AND EASTERN CONTINENTS edition of the Railroad Gazette is published each Friday at Queen Anne's Chambers, Westminster, London. It consists of most of the reading pages of the Railroad Gazette, together with additional British and foreign matter, and is issued under the name Railway Gazette.

CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

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VOL. XLI., No. 21. FRIDAY, NOVEMBER 23, 1906.

Much has been chronicled about events and incidents growing out of the San Francisco disaster, but little or no comment has been made in the press upon that phase of it relating to the demoralization of organization and its subsequent restitution. In spite of the wide interest shown, the public will doubtless never fully realize the size of the task with which large enterprises in particular have had to contend. An excellent illustration of this is afforded by the experience of the Southern Pacific Company, with its army of employees. So large a concern has not often been confronted with a combination of conditions involving the partial crippling of its facilities, the destruction of its main offices, the loss of many important records and the scattering of its thousands of employees, while at the same time it was under the necessity of relieving distress by free and unlimited use of its freight and passenger facilities. During the two days of the fire the general office work was at an enforced standstill, and everyone was looking out for his own salvation, but on the third day a handful of employees intuitively reported to the most likely place, namely, the division offices on the Oakland side. Here the company had established temporary headquarters, where only the urgent business of despatching refugees and supplies was transacted, everything else being given secondary consideration. The number of men showing up for work or for information about their future status was constantly increasing; there was neither work to do nor a place in which to do it, but many hung on, anxiously looking for an opportunity to run errands if nothing more. The commotion became so great that the despatchers could scarcely check their train movements. Meanwhile, the department heads were commissioned to cast about for office headquarters, which were rapidly being taken up at fabulous rates. Small amounts of space in various sections of Oakland were with some difficulty secured, and a portion of the forces are at the present time occupying offices transformed from lodging houses, club rooms and hotels. Wooden "horses" were hastily thrown together, across which boards were placed to serve as desks; those who were fortunate enough to find boxes used them as seats; many were for a time without either a board to write on or a box to sit on. Rush orders were placed by wire with neighboring cities for anything in the line of office furniture, stationery and supplies that could be found, and by hurrying them through on passenger schedule the forces were soon placed on a working basis. When face to face with an emergency that must be met, resourcefulness is put to the test and there develop more ways and means than would seem to exist under normal conditions. Thus, in following every avenue of information many lost records have been restored, and while inconvenience will always attend the loss of correspondence, no really serious complications have resulted. Upon the resumption of work, the place of every old employee was open for him. The building up of the business anew has in reality required the services of a force even greater than it used to be. The effort directed toward reorganization so quickly after the disaster restored confidence of the employees in the certainty of employment and inspired their willing and energetic assistance. Through it all they have evinced a spirit of loyalty and unanimity which has greatly aided the work of reconstruction. While many difficulties remain to be met before business will run with its accustomed smoothness, the efforts of the company to effect a rapid reorganization have nevertheless been attended with pronounced success.

The details of the British system of handling small freight (and often heavy freight as well) are described fully in another column. The general topic of British freight methods as compared with those of this country has often been discussed in the *Railroad Gazette*, as, for example, in the paper entitled "An American View of British Railways," reprinted in our issue of July 20, 1906. Both authors bring out the point that competition in Great Britain has had the effect of bettering facilities rather than of lowering rates; the splendid service is paid for by the shipper at an average rate not far from a sovereign a ton. But it is nevertheless true that the merchant, the manufacturer of small goods and the private customer get a service far better and far cheaper than that afforded even by the express companies in this country, and it is worth considering whether or not, as the country develops and the railroads become more nearly adequate in mileage and facilities to serve the needs of the population, it may not become profitable for them to develop a traffic which does not now exist, and which is willing and able to pay a high rate. It is not probable that it could ever become far reaching, in this country of great distances, for at once the possibility and the economy of the fast freight service in England lies in the fact that it is analogous to a passenger service, carried on at express speed, during the hours of the night when the lines are least obstructed by passenger movement. Moreover, it finds its chief, almost its entire usefulness, in England, within a radius of 400 miles from London. Its characteristic is that it is an over-night service; collections are always made at the close of the working day; delivery is always made prior to the beginning of the next working day. What could be accomplished in the way of creating new high class traffic if such a service were inaugurated in the New England states, in New York,

Ohio, Illinois, Indiana or Pennsylvania, can only be a matter of conjecture. But before the experiment can be made, it is essential that great additions be made to railroad facilities, in second and third tracks, sidings and equipment. The fast freight trains must be run substantially as units, without car detention or diversion; the freight must be concentrated for delivery at a few towns and cities only, or else the large American cars would prove an extravagance. In short, the obstacles of imitating the British fast freight system in this country are at present greater than the inducements, and yet the time may come when a fruitful source of new revenue can be attained thereby.

The Master Mechanics' Association specifications for locomotive boiler tubes require that they be circular within two-tenths of an inch, and that lap-welded iron tubes be tested to an internal hydraulic pressure of 500 lbs. per square inch and seamless steel tubes to 1,000 lbs. These requirements accord with those of the American Boiler Manufacturers' Association. This provides a suitable test of strength against rupture, but the stresses to which such tubes are subjected in service are just the reverse of that employed to test thm, since it is collapsing stresses imposed by external pressure that they must resist. It is well known, of course, that while the effect of pressure exerted against the internal surface of a hollow cylinder is to preserve its true form and tend to restore any departure therefrom, external pressure tends to increase any deviation from the true cylindrical form. Since, as the first-mentioned specification shows, boiler tubes even when most carefully made are not perfectly cylindrical, their ability to resist external pressures cannot be determined by rules applicable to the true cylindrical vessel of uniform thickness and strength. Instead, it must be deduced by experiment and by observation of flues collapsed in service. Oddly enough, the only systematic experiments of this character that had ever been made, until recently, were those of Sir William Fairbairn, made in 1858—nearly fifty years ago—and the formula that he deduced has been in common use since that time. According to this formula the length of the tube is a factor in its ability to resist collapse. But now, in the light of the recent experiments referred to,* Fairbairn's formula is shown to have only a limited application, it being established that there is a critical length beyond which the collapsing pressure is constant.

The experiments at the University of Illinois were made on standard steel boiler tubes from 1½ in. to 3½ in. in diameter, some of which were bought in open market and others were given by manufacturers. Fairbairn's law of lengths was ignored except to have the test pieces in excess of the critical minimum length. Nearly all of the pieces were 10 ft. long at the start, and in many cases three or more collapses were made by cutting off the collapsed portion after failure and testing the remainder. Both lap welded and cold drawn seamless tubes were tested; also some brass tubes of dimensions corresponding to the steel tubes. The results of these experiments show that the part of a long tube affected by collapse from hydraulic pressure is generally not longer than twelve times the diameter; beyond this the collapsing pressure is independent of the length. The law of inverse lengths was found to be true only for very short tubes, in most cases from four to six times the diameter. It was deduced from the data that the collapsing pressure is a function of the thickness of the tube and also of the diameter, varying directly as some function of the thickness and inversely as some function of the diameter. In the report of the tests the relation existing between the collapsing pressure and the ratio of the dimensions is exhibited graphically by means of curves, and formulae are deduced for values of P, the collapsing pressure. In applying any formula to calculate the collapsing pressure of a tube, the use of a considerable factor of safety is advised. Slight deformations, as well as lack of uniformity of material, are also important factors to be considered. Collapse of the tubes of certain kinds of stationary boilers was formerly a common source of accident and various expedients were resorted to for strengthening these flues to withstand the collapsing pressures to which they wer subjected. Tube collapses in locomotive boilers are comparatively few nowadays, notwithstanding the fact that locomotive service is far more conducive to the constant subjection of interior boiler parts to undue stresses and injury than any other sort of boiler service. Such failures as do occur are usually directly traceable to injury inflicted by the boilermaker, or resulting from corrosion, or similar causes. This speaks well for the product supplied by the manufacturers. The tests showed a uniformity in the character of the product that is referred to in the report as most creditable.

* Bulletin No. 5 of the University of Illinois Engineering Experiment Station: Resistance of Tubes to Collapse, by A. P. Carman.

ASPECTS OF NEW RAILROAD CAPITALIZATION.

The present time, which may almost be characterized as a "boom period" of new railroad capitalization, has certain aspects not so novel in themselves, but meriting special attention because accentuated by their own ratios and magnitude. The new capitalization has naturally been limited in the main to two familiar forms —new stock and new bonds, using here the latter term to include debentures and short time notes. The issues of bonds far exceed those of new stocks; and that in spite of the fact that many high railroad authorities, fiscal as well as operating, argue as an ultimate proposition in favor of the new security that takes its chances of a continued dividend rate rather than a security which carries a prior and rigid fixed charge, sometimes with a mortgage lien. In this connection may be noted, incidentally, as a tendency of the times in the case of great railroad corporations with well-assumed dividends, the slow but steady movement toward parity of market value of junior and senior bonds. They are still pretty far apart, and complete parity will, of course, never be reached, but the judgment of investors is beginning to grasp the fact that in past years the difference in price between the junior and senior securities of a large railroad corporation with a vast equity represented by share capital steadily paying dividends has been too large. It would be interesting to observe how low that disparity would fall were three influences removed, namely, (1) large variations in the money rate; (2) effects on its own finances of large bond issues by a corporation, and (3) the statutory restrictions on trust investment in favor of the senior classes of bonds.

But, while issues of railroad bonds have of late years been many in number and diverse in price, new issues of stock increasing railroad share capital have been by no means small, especially if we class in the same category bonds sooner or later convertible into stock. Present methods of such stock increases have their suggestions; one of them historical and a token of the development of sane railroad finance. In the earlier days of first railroad prosperity the absolute and "free" stock dividend was not uncommon. Even in those days it was deemed more prudent or, at least, more convenient to expand stock capital as a free gift to shareholders rather than increase the regular dividend. But that old-fashioned "stock dividend" in the absolute sense is practically a thing of the past. The famous stock dividend of 80 per cent. on New York Central shares and the later distribution to Rock Island stockholders sound now almost like fairy stories. In their place we have stock issues to shareholders at par, or slightly above, with the annexed and consequential "rights." The qualified stock dividend has superseded the absolute one, and not merely because the money is needed for new improvements, but also as a bar to public criticism. There must be, of course, in such a case, a margin for stockholders large enough to induce most or many of them to subscribe, in other words, to have a genuine value in rights, as well as to prevent rights from falling so low as to induce large speculative purchase of them. In a general way this marginal right is recognized even by such a body as the Massachusetts Railroad Commission when, under the state law, it compels new stock issues to be made at the market price, but fixes that price low. New railroad stock, however, as a gift is well-nigh extinct, both in practice and as an idea. Stockholders may get rights but not gratuities.

This question of stock rights of more or less value opens another field of discussion not altogether academic. Those rights connote the fact that they call for shares paying more to the owner than the usual rate of return on investment; in other words, that the railroad company is borrowing from its stockholders at a higher rate than it could borrow from the outside investor. Is or is not that process real stock watering? Massachusetts answers the question affirmatively. In her drastic policy against any form of stock watering she in effect capitalizes the excess of the regular dividend above normal investment return, and compels the stockholder to cash it. Stated in somewhat different terms she capitalizes the railroad by the same rule of paid-in cash during same prosperity as at the railroad's origin, and applies practically the policy to street railway and other corporations. In view that a railroad's ability to serve the public is greater when its dividend

requirement is less, the reasoning is sound practically and mathematically. But it involves some financial anomalies. By parity of reasoning it leads to the dictum that existing premium on stock outstanding is water; which it certainly is not. It ignores possible variations in rate of future dividends, which are not necessarily paid at a fixed rate as is the interest on bonds. This view also, except as the enhanced value of railroad stock may be reached by taxation, while objecting to increasing dividend requirements through issuing of new stock, does not run against a dividend fund increased, not through new stock, but by a higher dividend rate. To illustrate the case concretely, a railroad capitalized in stock at $8,000,000, which pays 8 per cent. dividends, with shares selling at $200, if it offers $2,000,000 of new stock to its shareholders at par, waters its stock, but if it increases the dividend to 10 per cent. does not do so. Yet in both cases the new dividend requirement is $800,000 with the public benefit decidedly favored by the first transaction if the $2,000,000 goes into improvements. Undoubtedly the public interest is better served, theoretically at least, if the new stock is put out at, say, 180. But the anomaly still remains. The high priced stock issued at par is criticised as stock watering; the higher dividend, which in the ultimate analysis is very like the old "free" stock dividend, is not so criticised.

Another feature of increased railroad capitalization is that prospective "rights" have lost most of their power to enhance stock values in the market. A few years ago such stock rights, even though dimly descried, sent the particular shares affected up sometimes by leaps and bounds. A year ago such a prospect left the stock comparatively unaffected even if it did not actually depress it; and, even now, in an average market less suspicious, the old conditions have not been regained, spite of a strong tendency of railroad shares to return to the earlier price soon after rights are "off." For an instance, the New York Central during the year has given stockholders rights which, if originally investing at par, at the market value plus the dividend have returned some 17 per cent. on the investment. With its great equities in the Lake Shore and other allied roads of the Vanderbilt group it is probable that its new stock distribution has not ended. Counting rights as dividends, they fix the New York Central as a 6 per cent. stock during the past twelve-year period, and that on a basis of rights put out within a single calendar year. While it is true that such a return is partly reflected in a price for New York Central stock, which reduces it on the basis of the regular dividend to a little below a 4 per cent. investment, and also that the costly terminal improvements promise no immediate return commensurate with the outlay, yet the price response to rights must still be regarded as strangely inadequate. The same rule has held in the case of other prosperous railroads, notably the "short" convertible debentures of the New York, New Haven & Hartford, whose outlays, while great, promise quick returns. Seeking the causes for such reduction of the power of stock rights in added railroad capitalization one must find it in the vastness of railroad improvements in progress or planned, reaching a financial magnitude in which the investor has lost bearings that he is just beginning to find again; the competitions with railroads of other forms of investment, and the overstrained condition of the money market. But added to these is undoubtedly the habit of the conservative investor nowadays of specializing rather than differentiating his stock rights. He treats them as though they were a kind of accidental bonus, emphasizes their immediate subtraction from the price of his stock instead of marking its quick recovery, and does not bethink himself to differentiate rights over a series of years as an annual addition to regular dividends; as, in fact, a dividend disguised under another name.

The attitude of shareholders and investors toward the extensive new railroad capitalization is obviously important, but not more so than that of the public in its economic relation of "consumer" of railroad service. At this point in their new capitalization the moral position of the railroad corporations is exceptionally strong. Through the old-fashioned gratuitous stock dividend there is now practically no stock watering to be an added burden on future public service; the interest rate carried by new bonds, while not so low as it was two or there years ago, is not high, and will probably go lower rather than higher with a relaxed money rate; and finally and, from the civic viewpoint, most cheering, in the great mass of stock and bonds put out for new capitalization, comparatively small amounts have gone into refunding and an enormous proportion into improvements bearing directly on public safety and convenience. How great that proportion is cannot be stated. But its vast size and the unquestioned public benefits that it will confer have a lesson for those who are making the railroads the objects of demagogical attack.

THE COASTWISE SITUATION.

The status of the competition and co-operation between the rail lines and the coastwise steamers from New York has remained unchanged for a great many years, but now has potential possibilities of radical new development, occasioned by the purchases of Charles W. Morse. Prior to Mr. Morse's entry into the field, the New York lines were as follows:

Old Dominion Line, New York to Norfolk, Va.—Majority of stock understood to be controlled jointly by the Southern Railway, Seaboard Air Line, Atlantic Coast Line, Norfolk & Western and the Chesapeake & Ohio.

Clyde Lines, New York to Wilmington, N. C., Georgetown, S. C., Charleston, S. C., and Jacksonville, Fla., with lesser services between New York and the West Indies, and between New York and Philadelphia; also services from Boston to Charleston and Jacksonville, and occasional irregular services to other points—The Clyde Line has been independent of railroad affiliations and has often been a disturber of rates.

Metropolitan Line, New York to Boston.—Independent.

Ocean Steamship Company of Savannah (Savannah Line), services from Boston and New York to Savannah, Ga.—Owned by the Central Railroad of Georgia.

Mallory Line, New York to Galveston, Tex., with occasional services to Brunswick, Ga., and Mobile, Ala.—An independent water line and a frequent disturber of traffic.

Morgan Line, New York to New Orleans and Galveston.—Owned by the Southern Pacific.

Maine Steamship Co., New York to Portland, Me.—Independent.

Exclusive of off-shore lines to Cuba, etc., and of the Long Island Sound fleet, this completes the list of coastwise lines from New York as it existed a year ago. The Cromwell Line of freight and passenger steamers, which for many years competed with both the Mallory and the Morgan Lines for the New Orleans trade, was absorbed by the Morgan Line several years ago.

Within the last year or so Mr. Morse has bought control of the Eastern Steamship Company running from Boston to ports in Maine and the Provinces; the Metropolitan Steamship Company, running between New York and Boston, and the Clyde Steamship Company. He also controls the Hudson River Navigation Company, and although this cannot be grouped with the coastwise lines, it is important as a feeder. It is safe to say that no one knows exactly what Mr. Morse's plans are, no one at least among the railroads with which he must either compete or co-operate. His field is a large one, and by virtue of abundant capital and a surplus of steamers he can create new services or remodel old ones. For some years the coastwise steamship lines have been allowed a differential below the rail rate, and a fair amount of harmony has been established with occasional disturbances. It is correct to assume, under existing conditions, that the coastwise lines require both the through traffic supplied to them by the railroads, and local traffic, in order to be successful, and that they cannot prosper on either alone. It remains to be seen in what way Mr. Morse will obtain the railroad support necessary. On the gulf, the Gould and Rock Island lines have great need of a through connection to New York, especially for their bulky traffic of the kind that travels more cheaply by water than by rail. This fact at the present time is neither more nor less true than it was during the old regime, but it derives new importance because Mr. Morse can presumably increase the efficiency of the old Mallory Line service if he cares to do so, and will be able to compete more effectively with the Morgan Line steamers. For the service between New York and Boston, he has already made a radical change in the practice of recent years by building two fast passenger steamers. When the old Metropolitan Line was first established it used to carry passengers between New York and Boston, but the more recent steamers of the line have had no passenger accommodations and have been devoted entirely to carrying out a daily freight service, the ships leaving New York late in the afternoon and arriving in Boston a day later. The New Haven road has not been able to keep the Long Island Sound traffic entirely in its grasp. New lines have cropped up every year or so, and the most recent arrival in the field, known as the Enterprise Navigation Company, is now conducting an active competition and selling through tickets at low rates in connection with trolley lines from Fall River to Boston. If the new Morse passenger steamers turn out to be fast and popular, they will doubtless add materially to the competition which the New Haven road has to face. Meanwhile, there are potential combinations which can be made between the Metropolitan Line and the Eastern Steamship Company, with a view to supplying the whole New England coast. Some years ago there were independent lines of small freight and passenger steamers

running from New York to New Bedford, but these gradually died out, and during the last 20 years it may be said that practically no water freight has been carried from New York to New England ports in opposition to the New York, New Haven & Hartford and the Boston & Maine, with the exception of that carried by the Metropolitan Line and by the occasional independent Long Island Sound companies.

It has frequently been said in the newspapers that Mr. Morse controls all of the coastwise lines except the New England Navigation Company, owned by the New Haven Road, the Morgan Line and the Old Dominion. This, of course, is not correct, for besides the Savannah Line, previously mentioned, there exists the Maine Steamship Company, the Boston & Philadelphia Steamship Company, the new Southern Steamship Company, running vessels between Philadelphia and Florida ports, and the old and strong company known as the Merchants & Miners Transportation Company, which runs ocean steamers from Norfolk and Newport News to Boston, Providence and Savannah. So far as is known, this company is also free from railroad affiliations; whether or not it will remain so is quite another matter. It would seem that the Merchants & Miners Company might be used quite effectively by a combination of railroad interests as a protection against the Morse Lines, in case the latter threatened the existing harmony. Both the coastwise steamship lines and the eastern group of rail carriers have been protected (at the expense of the shipper and also of the western rail lines) to an extent not always appreciated, by the navigation law requiring goods from one American port to another to be carried in American bottoms. Without this law, a flock of foreign "tramp" steamers would descend upon the coast whenever freights were dull, and many permanent lines would doubtless be established, with which the American lines, handicapped by higher charges for interest and wages, would be hard put to compete. The entrance of a group of American lines under common ownership bears a certain analogy to this condition, though of course in less degree, on account of the ease with which ships can be transferred from one service to another, to meet temporary requirements.

What Mr. Morse is going to do with the passenger traffic on the coast is another side of the matter, at once interesting and problematical. The history of coastwise passenger traffic in the United States makes a very interesting record and deserves a much longer account than can be given here. In brief, just prior to the Civil War, when railroad connections between the North and South were very poor, involving a break of gage at several points and a slow and unsatisfactory service, passenger business on the coast became very active. The steamers of that day running between New York and Charleston, Savannah and other southern ports represented what was then the climax of marine achievement for anything short of a Cunarder or a Collins liner. They were quite uniformly of the side-wheel type, with passenger accommodations then considered luxurious, and they made their runs almost as quickly as do the coastwise passenger steamers of the present day. Many of these boats were pressed into service during the war. Afterward, the coastwise passenger business again flourished for several years, but as the rail connections got better and better the water accommodations got worse and worse, or rather remained just about the same as they had been for years past, without additions of superior vessels to the fleet and without increases of speed. In the eighties the characteristic fleet of coastwise steamers was made up of slow and comfortable vessels, not at all luxurious and not attempting really to compete with the rail lines, and this same type prevailed until quite recently.

About ten years ago, however, three companies realized the possibilities of doing more than they had been doing for their passenger service: the Old Dominion Line, the Cromwell Line, and the Maine Steamship Company. The Savannah Line, a few years before, had built a fast, luxurious steamship named the "Kansas City," but did not continue to put vessels of this type in service, with the exception of the unsuccessful "City of Savannah." It is understood that there was a division in the Board of Directors of the Savannah Line about five years ago, at the time the existing new fleet was inaugurated, one part of the Board desiring fast passenger steamers of the "Kansas City" type, the other part standing out for steamers to carry freight exclusively. The result was the compromise type seen in the "City of Memphis" and her sister ships; large, seaworthy vessels with considerable freight carrying capacity and small coal consumption, but making no pretensions to speed or to luxurious passenger accommodations.

On almost all the coastwise lines the passenger business is very brisk during the hot months and practically non-existent during the cold ones, but the new Southern Pacific steamers building for the Morgan Line to run between New York and New Orleans are so much larger, so much faster and so much superior in their general type of accommodations to the ordinary coastwise steamers, that it is evident that the company intends to do considerably more with them as passenger carriers than has heretofore been attempted. Mr. Morse is manifesting the same intention in his turbine boats, the "Yale" and the "Harvard," which are to run between New York and Boston. It is said that these steamers will leave New York at 5 in the afternoon and be in Boston at 8 the following morning, which gives them an advantage over the Fall River Line and the other Sound lines, in that the passengers on these steamers have to get up early in the morning and complete their journey by rail. There is the compensating disadvantage that the new boats will run outside Cape Cod, but under ordinary weather conditions this should not prove a serious handicap. No announcement has as yet been made in regard to the new steamers which Mr. Morse is building for the Mallory Line, but it is probable that a fleet of fast steamers on the coast would pick up a passenger business unheard of under the present conditions, at least during the warmer months of the year. Moreover, if the competition became severe, rates could be made considerably lower than they are at present. For some years it has been customary for the coastwise lines to charge for a single passage a rate of fare approximately the same as the railroad, but including meals and stateroom accommodations, and subject to considerable reductions on round-trip tickets.

It is fair to say that the principal representative of a tolerably fast water passage service on the coast at the present time is the Old Dominion Line. The steamers of the Maine Steamship Company are faster, but there are not so many of them and their season is shorter. The Old Dominion Line has been just able to pay a 6 per cent. dividend and no more, while some of the freight lines have done considerably better, notably the Ocean Steamship Company of Savannah, which is controlled by the Central of Georgia Railway. It would be interesting to see, therefore, whether the coastwise passenger business, outside of that between New York and Boston and New England ports, will tempt Mr. Morse, and if so, what success he will have with it.

The principal financial details of the Morse holdings for the last fiscal year are given as follows:

	Capital stock.	Bonds.	Net earnings.	Per cent. on stk.
Eastern Steamship Company...	$3,000,000	$1,969,000	$275,000	9.1
Metropolitan S. S. Company...	3,000,000	1,000,000	225,000	7.5
Hudson River Navigation Co...	4,000,000	1,000,000	200,000	5.0
Clyde Steamship Company.....	14,000,000	4,000,000	1,200,000	8.5
N. Y. & Tex. S. S. Co. (Mallory)	14,000,000	3,800,000	850,000	5.0
Total	$38,000,000	$10,969,000	$2,750,000	7.2

A Probable Test of the Revised Rate Law.

The Interstate Commerce Commission has announced two decisions on motions to reopen cases filed under the old law, which amount to a ruling that where, at the time the law of 1906 became effective, a final order had not been entered it can be reopened.

The first motion was for the reopening of the case of Cattle Raisers' Association of Texas vs. C., B. & Q., et al., the Chicago Live Stock Terminal Case. In this case a final order was made in November, 1905, and the motion to reopen is denied.

The other motion was for reopening the case of the cattle raisers against the Missouri, Kansas & Texas, et al., for a reduction in rates from Texas to Chicago. This case was also decided last year, but the motion to reopen has been granted as no final order had been issued. In announcing this decision Commissioner Prouty says:

"The new Section 15 confers upon the commission power to enforce what has always been required in the statute, namely, just and reasonable rates, by the application of a new remedy, and, as applied to cases like this, in this way alone has the jurisdiction of the commission been enlarged. The new section provides as conditions that there shall be formal complaint and full hearing. Both of these prerequisites have been practically complied with in this proceeding, but both complainant and defendant should have leave to submit whatever additional testimony they desire, and thereupon it is not only the right, but the imperative duty, of this commission to make an order for or against the defendants, under the new fifteenth section. To hold otherwise, this case and many others in which large sums of money and much time have been expended must fail, since the old section is superseded by the new, and the amending act contains no provision continuing the old section in force as to cases previously brought before the commission: the law should not be so interpreted in the absence of explicit provision to that effect."

Some lawyers doubt the soundness of this decision of the Commission, because there is no provision in the law passed this year for continuing cases filed under the original act; but there can be little doubt that Mr. Prouty's action conforms to the liberal spirit of the original law; and no one has accused Congress of intending to be any less liberal toward shippers now than it was then.

If the action of the Commission in reopening this case is sus-

tained by the courts it will doubtless become the test case, settling the question of the Commission's authority to prescribe rates. In this case the Commission on August 16, 1905, held that defendants' advances in live stock rates during 1903 were unjust and unreasonable, and that "the present rates are unjust and unreasonable to the extent of such advances." It is safe to assume, therefore, that, unless the roads can show a substantial change in conditions since August 16, 1905, the Commission will order a reduction of rates to those in force before the advance of 1903. Such an order if resisted by the roads will result in a test of the constitutionality of the rate-making provision of the law as now revised.

According to a press despatch from Washington the Interstate Commerce Commission is puzzled by the questions: Are melons fruit? Are potatoes fruit? What is fruit? These questions have been propounded by certain railroads in connection with the clause of the revised rate law which permits free transportation for caretakers to travel with "fruit." The potato carrying roads come forward and say that they have been in the habit of furnishing transportation to caretakers accompanying carloads of potatoes, and they gravely ask, "Are potatoes fruit within the meaning of the law?" The Colorado melon growers present a similar request. The commissioners have determined to hold a special session to define "fruit" as the term is used in the law. How would it do for the railroads to hold a "special session" and withdraw all such free ride privileges? Of course, the transportation of a legitimate caretaker is not free at all; the price for carrying the fruit (or potatoes) pays the road for all the service which it performs in connection with it. If a freight charge is $100, including a $20 ride, why not make it $80, excluding the ride? Then there would be a chance to give equal service and treatment to all; and the business would be put more nearly on a sound basis. Incidentally, such a change would put a stop to unnecessary caretaker and perhaps weed out some abuses. It might bring about a reduction in the annual number of drovers killed and injured in cabooses, and the consequent damage bills. If, in the case supposed, the freight carriage is really worth $100, and the true charge for goods and man ought to be $120, why not make it $120? Could the commission or the courts then entertain the claim that the man was being carried free?

Wheeling & Lake Erie.

The present First Vice-President and General Manager, some six months after he came to the road from the Harriman lines in Oregon, made the following statement, which suggests the present policy of development on the Wheeling & Lake Erie, in the annual report for 1905:

"The future of this property is dependent wholly on development of its facilities, as the business that can be obtained along its lines should enable it to multiply its earnings per mile of road fully three or four times."

The road forms the connecting link between the Wabash main line at Toledo and the Pittsburg entrance over the Wabash-Pittsburg Terminal, which joins the Wheeling & Lake Erie at Mingo Junction, on the Ohio side of the Ohio river, just across from West Virginia. The Wheeling & Lake Erie also has branches running north from the main line to the lake ports of Huron and Cleveland, and a branch is being built to Lorain. The Cleveland division runs southwest to Zanesville, and there are numerous branches in the coal areas which the road touches. These are in three districts, the Massillon district, the Middle district on the Toledo division, and the Eastern Ohio district, the last with a total daily producing capacity of 20,700 tons, and by far the most important. Wheeling, W. Va., is the southeastern terminus of the road. Thus, although lying in highly competitive territory, the Wheeling & Lake Erie has large possibilities. Aside from the traffic which it will naturally receive as the Wabash connection between the Pittsburg district and the West, as well as its potential possibilities as part of the Gould main line to Atlantic tidewater when the gap between Wheeling or Pittsburg and Cumberland, W. Va., shall have been filled, it runs through a district admirably suited to the heavier kinds of manufacturing, has a chance for ore traffic between the lake ports and the iron centers, a large existing traffic in coal, and large possibilities of business in finished iron and steel products.

In past years the road has been too poor to take advantage of its opportunities. By means of authority, given at a special meeting of the stockholders on September 26, 1905, an issue of $35,000,000 50-year 4 per cent. general mortage bonds was created to provide for retirement of underlying bonds amounting to $15,000,000, and, more important to the welfare of the property, to provide funds for improvements and extensions. An issue of $8,000,000 three-year notes secured by $12,000,000 of these bonds and certain equipment was sold at 95, realizing $7,600,000. Something over $4,000,000 of the proceeds of the notes was paid for equipment and for unsecured floating debt, leaving a balance of $3,400,000 available for general betterments and improvement. Of this amount $1,740,000 had been spent up to the close of the fiscal year ended June 30, 1906.

These general betterments have taken the form particularly of improvements to the line, involving both betterments of the existing roadbed and building of new road to secure better alinement, grades and curvature. On the Toledo and Pittsburg division there were laid 70 miles of 90-lb. rail; on the Cleveland division, 16 miles. For February, 1907, delivery, 10,000 tons or a little more than 70 miles of new 90-lb. rail has been ordered to carry on the laying of heavy rail on these two divisions. During the year, 189 miles of main track were ballasted, 16 miles of passing sidings and 12 miles of new yard tracks were built, and three miles of industry tracks were laid to some 20 different industries. These are large improvements for a road with 442 miles of line operated, of which only 216 miles is comprised in the main line, although counting the line from Cleveland to Zanesville as main line, the total is brought up to 360 miles.

During the summer and fall of 1905 various surveys were made with the object of obtaining a low grade line over Greenville Summit, west of Massillon, where there is a 1 per cent. grade against westbound traffic. After examining into three different routes, it was decided to build a line from Bolivar via Justus, on the Cleveland-Zanesville division, and through the Sugar Creek valley to Orrville, 22 miles. This line has been built under the name of the Sugar Creek & Northern and is nearly finished. It saves 6.6 miles of distance, has a maximum grade of between 0.4 and 0.5 of 1 per cent. as against 1 per cent. on the old line, maximum curvature of 3 deg. as against 9 deg., makes a saving of 1,095 deg. of total curvature, and has 220 ft. of ascents and descents (westbound) as against 490 ft. on the whole line. At a point two miles west from where the new line crosses the Cleveland division 625 acres of land have been bought as a site for permanent locomotive and car repair shops, engine houses, store rooms and division offices. This is on a part of the line where there is four miles of tangent and level grade, with abundant water supply. A large hump yard to contain 46 miles of track is to be built at this intersection of the Toledo-Pittsburg main line and the Cleveland-Zanesville line. The cost of the new cut-off is estimated at $1,000,000. Further surveys have indicated the possibility of making the Wheeling & Lake Erie, from the summit west of the Ohio river near Jewett to each of its lake ports, a line with no grade against westbound traffic steeper than 0.4 of 1 per cent. The eastbound traffic is now much lighter than the westbound, so that there is not the same necessity for reducing grades in that direction, but later on it will be possible to reduce eastbound grades, with the exception of pusher grades out of lake ports, to a maximum of 0.3 or 0.4 of 1 per cent. The additional advantages to be gained in operating efficiency from double-tracking are clearly shown in a statement of trains running over the line between Toledo and the Pittsburg Junction, published in another column.

The branch to Lorain is now under construction by the Lorain & West Virginia, controlled by the Wheeling & Lake Erie. It is to connect with the steel works at Lorain and stone quarries at North Amherst, and to comprise, with branches to quarries, some 35 miles of line. Its tonnage is estimated at 50,000 cars a year. It is to be in operation by January 1.

In spite of a loss in coal traffic on account of the coal strike in Ohio, which began April 1, 1906, and lasted until July 20, estimated at $350,000, the gross earnings of the road increased nearly 16 per cent. and net earnings 63 per cent. For the first nine months of the fiscal year before the strike, the increase in gross earnings was at the rate of 28 per cent., with net earnings larger by 100 per cent. than in the year before. With an increase of 28 per cent. in revenue ton-miles, cost of conducting transportation decreased 3 per cent. There were, however, increases of 8 per cent. in cost of maintenance of equipment and of 14 per cent. in general expenses, in spite of which the percentage of operating expenses to earnings was 71 per cent. against 79 per cent. in 1905.

The train load shows an increase of 26 per cent., from 422 tons in 1905 to 537 tons last year. Including company freight the figures were 443 tons and 562 tons. An increase of 37 per cent. in the mileage of empty freight cars against an increase of 15 per cent. in the mileage of loaded cars probably reflects a larger disproportion of westbound and eastbound traffic. Freight density increased 28 per cent., to 2,191,627 tons one mile per mile of road. Freight earnings were 87 per cent. of gross against 83 per cent. in 1905. It is not possible to tell from what classes of traffic came the gain in freight earnings, as no table of commodities carried is given, but it is fair to assume that it was largely in the heavier kinds of traffic, such as coal, ore, iron products, cement, etc. Neither is it possible to work out the unit maintenance figures with the exception of maintenance of way, as expenses are not given in detail. Roadway maintenance cost $1,793 per mile against $1,657 in 1905.

The present report is a splendid record of achievement on the part of the new management. Gross earnings have largely increased, net earnings remarkably. In spite of a much larger traffic, the direct cost of carrying it has been lowered while more has been

spent on maintenance. A financial plan has been adopted which provides for the improvements intended to make the road an efficient carrier, and this betterment work is being largely carried on. It is an interesting conjecture to consider what will be the position of the Wheeling & Lake Erie five or ten years from now. Particularly if the Gould plan of a through line from ocean to ocean is carried out, the road has large possibilities. Already the business from the Pittsburg district is growing and, according to the report, the greatest misfortune is that there is not sufficient equipment with which to handle it. With a large business from this source, a through traffic between Baltimore and the West and the improvements to the line necessary for carrying this large business economically, the Wheeling & Lake Erie might well come to be a highly successful railroad.

The principal statistics of the last two years' of operation are as follows:

	1906.	1905.
Mileage worked	442	442
Freight earnings	$4,639,852	$3,812,461
Passenger earnings	466,748	534,410
Gross earnings	5,318,801	4,595,607
Maint. way and structures	792,543	732,228
Maint. of equipment	871,930	763,899
Conducting transportation	1,951,802	2,015,119
Operating expenses	3,672,156	3,639,135
Net earnings	1,556,646	945,471
Net income	92,294	Def., 193,360

Philadelphia & Reading.

The Reading Company, like the Rock Island Company, is a railroad holding corporation. Instead, however, of controlling only railroads, it includes industrial corporations among its subsidiaries. The Philadelphia & Reading Railway covers the 1,000 miles of railroad directly operated, in addition to which the Reading Company owns an interest in a total of 1,126 miles of other roads, the principal of which is the Central Railroad of New Jersey, with 648 miles of line. The Reading Company also controls the Philadelphia & Reading Coal & Iron Company, through which it mines its anthracite and bituminous coal, and the Reading Iron Company. The income of the Reading Company, whose shares are those traded in in the stock market, is derived from the surplus earnings of its underlying companies, principally the Railway Company and the Coal & Iron Company.

Gross earnings of the Philadelphia & Reading Railway for the year were $40,500,000, a gain of $3,000,000 over 1905. This in spite of the influences of the anthracite coal strike which lasted from April 1 to May 10, 1906, and except for which, the year would have shown remarkably favorable results. The effect of the strike is shown more clearly in the income account of the Coal & Iron Company, whose net earnings were nearly $1,000,000 less than in 1905. Net earnings of the Railway Company were $18,400,000, against $18,000,000 in 1905.

The net income for the year before dividends was $8,923,824, against $8,369,600 in 1905. From these sums were deducted for improvements $3,500,000 in 1906, and for improvements and insurance, $1,000,000 in 1905, consequently the surplus after appropriation for betterments was $5,384,472, against $7,359,162 in 1905. To the Reading Company was paid $6,000,000 in 1906, against $4,000,000 in 1905. The extra amount necessary to make up last year's payment of $6,000,000 to the holding company was drawn from the railroad's accumulated surplus of previous years.

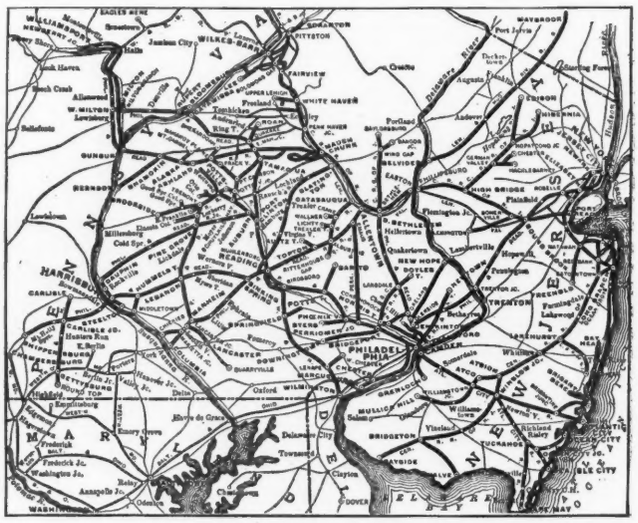
The gain of $3,000,000, or 8 per cent., in gross earnings, was largely offset by an increase of $2,600,000, or 14 per cent., in operating expenses. Maintenance of way increased 17 per cent.; maintenance of equipment, 12 per cent., and conducting transportation, 15 per cent. Per mile operated, maintenance of way cost $3,195, against $2,698 in 1905. Maintenance of equipment cost $2,228 per locomotive in 1906, against $2,554 in 1905; $610 per passenger car, against $475 in 1905, and $62 per freight car, against $59 in 1905. These unit charges are all high, particularly in maintenance of way, since most of the $3,539 per mile spent out of earnings for improvements was used in betterment of the line.

The more important betterments, costing over $2,800,000 of the $3,500,000 spent for improvements, were enlargement of classification yard at Rutherford, double tracking of the Philadelphia, Harrisburg & Pittsburg, additional tracks on the main line, third and fourth tracks on the New York branch, second tracks on the East Pennsylvania branch, and enlargement of the locomotive and machine shops at Reading. With the increased facilities provided, the company was able to build several locomotives during the year. The efficiency of the product may be judged from the fact that the train which made one of the fastest runs on record last summer from Camden to Atlantic City, in the course of which it ran 12 miles in eight minutes, was hauled by an Atlantic type locomotive built at the Reading shops. Besides the charge of $609,000 to improvements for shop tools, the maintenance of equipment item, repairs and renewals of shop machinery and tools, increased during the year 100 per cent.

Under conducting transportation nearly every item shows an increased cost, as is to be expected with an increase of 101,000,000 ton-miles of coal and 260,000,000 ton-miles of merchandise traffic, and 27,000,000 passenger miles, besides 41,000,000 freight ton-miles in company service. Instead of a credit of $163,000 for car service in 1905, there was a charge of $82,000. There was a large proportionate increase in rents of buildings and other property, which rose from $6,000 in 1905 to $116,000 last year. It will be interesting to observe in succeeding reports the effect of the recent wage increase of 10 per cent. All conducting transportation items which include wage payments are already much higher than in 1905.

The revenue train load was 409 tons, against 388 tons in 1905. This in spite of the fact that half of the tonnage was merchandise. The heavy traffic character of the road is also emphasized by the increase of 115 in the number of locomotives during the past year, and that with 1,000 miles of line, there are 486 miles of second and 54 miles of third and other track.

For the first time information is given in the report in regard to the Reading Iron Company, which, in a small way, is an important asset of the holding company. The Reading Company owns all its capital stock, on which 6 per cent. annually is paid. Enlargement, rebuilding and modernizing of the Iron Company's various plants has been paid for out of earnings, as well as purchase of the Pennsylvania Steel Company. With $1,000,000 capital stock, the company's assets amount to $12,000,000.



Reading Company's Lines.

The following table sums up the results of the last two years' operation of the Philadelphia & Reading Railway:

	1906.	1905.
Mileage worked	1,015	1,015
Coal freight earnings	$17,198,247	$17,163,351
Mdse. freight earnings	15,220,441	13,036,536
Passenger earnings	6,216,316	5,717,399
Gross earnings	40,563,725	37,495,719
Maint. way and structures	3,195,152	2,738,215
Maint. of equipment	6,330,882	5,650,984
Conducting transportation	11,896,370	10,387,563
Operating expenses	22,137,172	19,480,350
Net earnings	18,426,553	18,015,369
Net income	8,923,824	8,369,600
Appropriated for improvements	3,539,352	979,643

NEW PUBLICATIONS.

Management of Electrical Machinery. By Francis B. Crocker and Schuyler S. Wheeler. New York: D. Van Nostrand Co. 223 pages; 5 in. x 6½ in.; 131 illustrations. Price, cloth, $1.00.

This is a revised and enlarged edition of the "Practical Management of Dynamos and Motors" by the same authors. It sets forth the more important facts with which the man in charge of electrical machinery should be familiar. The methods of handling generators and motors are dealt with in the opening chapter; those next following take up the installation of machines, the foundations and mechanical connections. These points are covered in considerable detail and the general rules laid down may well be applied to any other machinery, wherever it is desired that the installation and operation shall be first class. The second part takes up the testing of electrical machinery. In the third part the troubles that arise in the operation of both generators and motors are localized and the specific remedies prescribed. Each of the ten chapters deals with a particular symptom. These are: Sparking at the Commutator; Heating of Commutator and Brushes; Heating of the Armature; Heating of the Field Magnets; Heating of Bearings; Noisy Operation; Speed Not Right; Motor Stops or Fails to Start; Dynamo Fails to Generate; Voltage Not Right. Each is treated of in detail, and where the difficulty may be brought about by more than one cause, every such cause is stated and the remedy given

categorically. The fourth and fifth parts are devoted to the peculiarities of different classes of electrical machinery as made by the more prominent manufacturers, especially as regards regulation, and conclude with the management of railway motors. The book will be found to be a valuable work of reference for all who are confronted with the peculiar problems that it takes upon itself to solve.

Consolidation Type Freight Locomotives. Published by the American Locomotive Co., New York. 68 pages; 32 illustrations; 6 in. x 9 in.

This pamphlet describes consolidation (2-8-0) type freight locomotives weighing more than 175,000 lbs., and is uniform with the pamphlet issued in October describing engines of this type weighing less than 175,000 lbs. The present publication is the fourth of the series and illustrates and gives full specifications of 28 locomotives varying in weight up to 250,000 lbs.

CONTRIBUTIONS

Collapse of the Hotel Bixby.

Detroit, Nov. 13, 1906.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The Associated Press gave currency to a report that the Kahn Construction Co., Detroit, Mich., had a contract for the construction work of Hotel Bixby, Long Beach, Cal., which collapsed on Nov. 9, resulting in death and injury to a number of persons. We beg to give herewith a true statement as to our connection with this building.

The building was originally designed and carefully detailed with twisted bars, and the contract was let to E. S. Spalding, Los Angeles, Cal. When the owner of the building observed some buildings of our system of hollow tile construction, he decided to use the same for his floors and so instructed his contractor. In accordance with this, Mr. Spalding purchased from us the necessary bars for the floor slabs and beams, retaining the original design with twisted bars for the footings, columns, lintels and veranda floors. We have never had anything whatsoever to do with the construction of the building, nor has any of the men directly connected with this company ever been near the building.

The damage which can be done us by a report that we have been in charge of the construction work is very serious indeed. Our steel is used in probably a thousand buildings at the present time. We try to determine the responsibility and reliability of the contractor at the time of selling our steel to him, but one will readily understand that it is not possible for us to safeguard the work of every contractor, and therefore if he is inclined to do bad work it is impossible to prevent serious catastrophes. If the Carnegie Steel Company, for example, were to hold itself responsible for every building wherein its steel beams are used, it would have a very serious undertaking on its hands.

TRUSSED CONCRETE STEEL CO.,
J. Kahn, President.

[Since receiving the above letter the verdict of the coroner's jury has been returned. According to press despatches, the cause of the collapse is ascribed by the jury to the premature removal of the supports of the fifth floor and proceeding with the construction of the roof before the supporting concrete had time to set properly. No individual was held criminally responsible. According to the same despatches, Contractor Spalding declared the exact cause of the collapse still to be unknown.—EDITOR.]

Steam Locomotive and Electric Locomotive Power.

New York, Nov. 20, 1906.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Your editorial comments* on my letter on the cost of steam and electric locomotive power suggest a few explanations to reinforce my argument.

The objections raised are: (1) That my results are 300 per cent. larger than those obtained by other methods of testing, and that the difference cannot be accounted for; (2) that I neglected the number of trains and calculated the resistance by weight alone; (3) that the actual coal consumption of electric roads per horse-power hour is more than 3 lbs.; (4) that the comparison of the two kinds of power is not made on the same basis. To (1) my reply is that the test runs do not directly show the total coal consumption in service, which must be inferred by making allowance for the increase caused by various differences between test runs and actual commercial service. The test runs made by Mr. Bion J. Arnold, which followed actual service conditions much more closely than other tests, substantially confirm those obtained by my method. Large differences between test runs and actual practice occur even where conditions for both are very much alike.

Railroad Gazette, Nov. 16, 1906, page 421.

One instance from experience may be cited: For a large pumping plant of a city of 400,000, the commissioner of public works claimed, supported by the initial tests, that the power was produced for less than $50 per horse-power year. The writer was called upon, by those who wished to sell electric power, to investigate. From the official reports of the water department it was proved that the power was produced at a cost of $95.34 per horse-power year. This pumping plant is operated with a load factor of about two-thirds. Steam locomotives work with a load factor of one-tenth to one-fifteenth. Much larger differences between tests and actual service may therefore be expected in the latter case.

Objection (2) is natural, because I dealt with averages only. The average resistance per ton for all the freight trains on a railroad has only one value, however much the actual resistance per ton may vary. The formulas for train resistance quoted show the variations with length of train, with speed and with ratio of load to weight of cars. Heavy trains have at high speed less resistance than light ones. The weight of the cars of freight trains produces much greater resistance per ton than the weight of the load.

The Burlington brake tests reported by Mr. Wellington were made with much lighter trains and smaller percentage of the weight in the form of load than is shown by trains on the roads I considered. Their train resistance is therefore greater than that on the roads which my estimate dealt with. As regards passenger trains, I state in my paper that for some of the trains my resistance of 11 lbs. per ton would be much too small. Since I wrote my letter I have been informed of the results obtained in the tests made with the new electric locomotives of the New York Central. They show train resistances for the speeds here considered, given by the formula $R = 1.8 + \frac{V}{9}$. This gives a resistance of 6 lbs. per ton for the usual passenger train speeds. The average number of cars per passenger train on the roads considered by me varies from 5 to 7.

The large resistances observed with one or two cars at high speed have therefore no bearing on this investigation. I am here comparing the steam and electric locomotives on the same basis, using for both the same speed and the same size of train. By taking 11 lbs. per ton I amply allow for the larger resistance on the short passenger trains and for the waste of power by the frequent use of brakes on the comparatively few suburban and local trains of the lines considered.

The objection under (3) is true for most existing electric roads. I have assumed for electric operation of trunk lines altogether different conditions from those now prevailing on electric roads. The 15,000 volts on the contact conductor will make practicable, on the roads considered, power stations of from 10,000 to 30,000 h.p. with a load factor of 0.6 to 0.75 and direct power transmission of 96 per cent. efficiency from the stations to the locomotives. An average efficiency of two-thirds, or more, from the power station to the rim of the drivers of the gearless locomotives can therefore easily be attained. The present electric roads have generally small geared motors of much lower efficiency than is shown by gearless locomotives. With direct currents and low voltage the transmission losses from the power station to the motor cars, inclusive of those in the rotary converter sub-stations, are generally five to six times as large as they would be under the conditions I assumed. With the alternating current lines so far in operation the voltage in the contact conductor is generally either 6,600 or 3,300 or less, and transformers with an average loss of 4 per cent. are interposed between the power station and the locomotives, making the total transmission loss about three times that which would exist under the conditions I assumed. The power stations of the present single-phase lines are generally only about one-fifth, and their load factor about one-half, as large as will be obtained in electric operation of trunk lines. Under these conditions larger coal consumption is inevitable. The late Dr. Emery, an authority on the subject, gives for a station with 2,500 h.p. reciprocating engines and a load factor of five-eighths, a coal consumption of 1.41 lb. per mechanical horse-power hour. This is equivalent to 1.5 lb. per electrical horse-power hour. The engines of large Atlantic liners are using approximately this amount of coal per horse-power hour. My assumption of 2 lbs. of coal per horse-power hour for the station described is therefore a liberal one. Much lower estimates than 3 lbs. of coal per horse-power hour at the rim of the driver might be quoted.

The objection under (4) expresses a vague but probably general feeling that more favorable conditions have been assumed with electric than with steam locomotive operation. The essence of electric operation is the concentration of power production. The power furnished by 50 to 200 of the present locomotives will be produced in one power station. This concentration of power production creates much more favorable conditions for it. A load factor of one-tenth to one-fifteenth is thereby changed to 0.6 to 0.75. The required capacity of the power station will therefore be between one-sixth and one-eleventh that of the present locomotives, instead of equal to it, as figured in a recently published estimate.

My calculation is apparently complicated, but in reality simple. It ascertains the average train resistance per ton by taking about the largest values found by recent dynamometer car tests and adding to them for losses on curves and by the use of the brakes. It then determines from official reports the ton miles of freight and passenger trains. From the ton miles and the train miles resistances per ton and the horse-power hours needed to do the work are easily determined. From these and the amount of coal used, the amount of coal used per horse-power hour is found. The apparent complication arises from the frequent repetition of the same simple operation. A large part of this repetition is for the purpose of proving the general truth of the statement that the steam locomotive uses from three to five times as much coal as an alternating current electric locomotive doing the same work and fed from a power station.

JOSEPH MAYER, M. AM. SOC. C. E.,
Consulting Engineer.

The British System of Cartage and Delivery of Freight at Terminals.

One of the most interesting of the many divergencies of practice between American and British railroads in the matter of freight transportation is the completeness of the British scheme for gathering from the premises of the shipper and delivering at the premises of the consignee, without bother to either. British railroads are not content merely to haul their traffic from point to point on their roads, leaving one agency to secure it at the source and another at the destination to dispose of it. They prefer to see the whole thing through from start to finish, and little by little have volunteered (albeit under stress of keen competition) a remarkable series of facilities to the public. From quite early times the tendency seems to have been to provide improvements, often in advance of actual requirements, rather than to decrease the remuneration for the services rendered, as in this country. The trading community may thus to-day be said to have got about to the zenith of its privileges at the present tariff, which has remained substantially unaltered for years, and so gradually and quietly have the British companies educated their customers to better things, that they get but scanty honor for it in their own country.

The present paper shows what the London & North Western Railway, as a leading road, will do for its patrons in this matter of carting. But first, in order to clear the ground, it must be stated what, in common with its confrères, it will *not* do. There are certain kinds of more or less unremunerative freight, such as bricks, coal, creosote, gravel, hay and straw, iron ore refuse, lime, salt, etc., in bulk, manure, peat, scrap iron or steel, sand, slates, turf, wood blocks, and so forth, which the railroads do not collect or deliver at terminals, and for which only the lower, or station-to-station rates exist. Apart from these and like commodities, the companies, whether by their own teams or those of their carting agents, undertake the cartage of the bulk of the traffic at both ends of the journey without extra charge. To this established practice there are exceptions in the case of traders who prefer to arrange their own cartage; then a cheaper (station-to-station) rate is charged, or, if no such rate is quoted on the companies' books, because the freight is of a kind generally carted by the companies, a rebate is allowed off the collected-and-delivered rate. On the other hand, traffic conveyed at a station-to-station rate will be carted by the companies, if desired, at an extra charge. Nor is there any shirking in the case of heavy and unwieldy articles, such as boilers, girders, armor plates, machinery, etc., for which special vehicles are built by the roads, and expert gangs of men provided.

If the cartage agency system in Great Britain is not dead yet, its decease appears imminent, so far, at least, as the more prosperous railroads are concerned. But since the companies' own cartage equipments are kept only at average requirements, outside help continues to be requisitioned in times of pressure. The North Western declared its independence in this respect when, in July, 1901, it ended a long-standing arrangement with Messrs. Pickford & Co., a firm which had existed as carriers before the advent of railroads, and whose control over the business in the early days rendered it unwise too hastily to sever the alliance that had been formed with it. At the present date the North Western has a stock of 5,500 road vehicles employed in carting merchandise hauled in freight trains, the motive power being provided by a stud of some

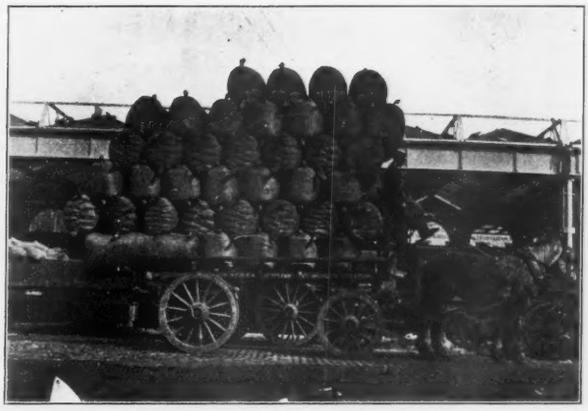
Steam Lorry for Collection and Delivery Work in a Hilly Country District.

5,000 horses. These are worked by 4,720 carmen and cart boys, 240 stablemen and 280 supervisors, while they are also supervised, when in the freight depots, by the foremen or inspectors in charge there. In the streets of the larger towns the movements of the carmen are directed by the supervisors, who are provided with light carriages or motor cars for rapid travel, but the men have an additional inducement to do well in the form of a bonus which is offered them by the company. Figures are consulted to find what has been a fair average weight per day over a normal period in a particular district, the average is slightly raised, and the company then says to the carmen, "For every ton over this minimum we will pay you (say) 6d. per ton," or proportionately for a smaller surplus. Under this plan the loafers have grown energetic, and the whole body of men take greater interest in their work, with the best results to the public, the company and themselves.

The types of vehicle most commonly employed are illustrated here. Generally they are light, and they are almost entirely horse-drawn. Although a steam lorry has been found successful in a hilly district in North Wales, the speed with which town cartage work is done has, up to the present, proved an obstacle to the employment of motor vehicles. This may seem paradoxical, but is explained by the system of lading. At a large town freight depot consignments for delivery begin to arrive soon after midnight, and by 7.30 a.m., when the horses are ready for work, perhaps 200 vans have been loaded, and these, by 8 a.m., are all despatched on their rounds. There are, say, another 200 vans still available, and the loading of these is at once proceeded with and completed by 10.30,

by which time the first vans are beginning to return empty. All that has to be done is to hitch the returning animals to the newly laden vehicles and send them out again. The same teams thus provide motive power for two sets of vans. Motors could not be detached from the vans like horses, to serve a double set of vehicles, and it would not pay to keep the machinery idle for long periods while vans were being loaded and unloaded at depots. Furthermore, in crowded streets motor vehicles have little advantage over horses in point of speed, while for backing up to warehouses and standing at the angles often necessary in busy thoroughfares, they are less suitable than horse vans, with their simple fore-carriage and possible sideways position of the horse.

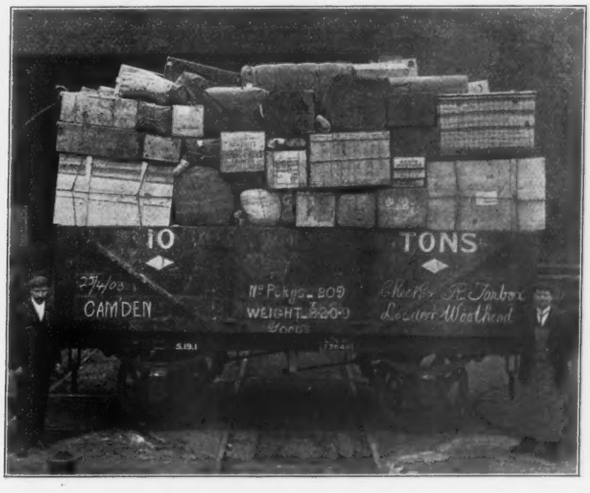
Single-Horse Van for Collections and Deliveries.



Two-Horse Lorry for Collections and Deliveries.

The process of delivery and collection is as follows: The carman, having finished his deliveries, starts on his collection rounds. He knows his regular customers, but he will also keep a watchful eye on every window on his route for the familiar card bearing a picture of Britannia, the North-Western Company's badge, the exhibition of which tells him that a call is desired. If he fails to get into contact with any intending shipper, or if the consignment requires unusual strength, the shipper will send by telephone, telegraph, messenger or post an order to collect, and this is responded to as promptly as the engagements of the cartage crew permit; the company often resorting to hiring rather than incur delay. The custom is to hand the carman a "consignment note," setting forth details of the consignment, its destination, and the shipper's wishes in respect to the charges. With the acceptance of this the contract begins. On reaching the depot with his load, the carman weighs in and backs as soon as may be to the unloading platform in the shed, where "checkers" are stationed, who will accept his notes and check his packages off with them as the van is unloaded by porters. Each package will be carefully weighed and the result recorded on the consignment note, both package and note being then transferred to a berth in the shed, alongside of which stands the car, presided over by a second checker and a loader-up. Their duty is to see the package carefully stowed in the car, the number of the car recorded on the note, and the note placed ready to be fetched by the shipping office messenger. In the shipping or billing office the particulars on the note, as well as rate and charges, are transferred to an invoice, which document usually goes forward to destination in advance of the car, a copy being retained for accounts and purposes of reference. On arrival of the package at its destined depot, in town or country, a "delivery sheet," copied out from the invoice by the staff at the receiving station, is in readiness, so that there need be no delay in placing the package, duly checked once more, on the proper van for delivery to the consignee's establishment, where the carman obtains a certificate of receipt on his delivery sheet. Here the contract ends. The package, or consignment of packages, has been transported throughout, from the sender's premises to the door of the receiver, by the railroad company unaided, at a charge inclusive of the services of collection and delivery and in some cases a short period of warehousing also. The delivery sheet is returned to the depot, with any money collected by the carman, and filed for future reference, the collection of any outstanding cash entered on it being entrusted to a staff of collectors. Of course there has to be a limit to the work undertaken in this way. Free collection and delivery only obtain within certain liberally wide boundaries, beyond which extra fees are charged for the cartage services. These limits are agreed on by all the railroads concerned at each place. The companies also have a time limit for collections, which enables the carmen to get to their home depots in the evening in time for the depot staff to relieve the vans of their loads and despatch the freight the same night by the proper services.

Cartage Inspectors.



Characteristic Merchandise.

The excellence of these services is such that for many years past it has been possible to have freight collected in London late in the afternoon and delivered in almost any town south of Scotland the next morning, while now the larger towns north of the Tweed, such as Edinburgh and Glasgow, have been brought within the same radius, notwithstanding the 400 miles separating them from the metropolis. This close linking up of the centers of industry has been largely aided by the fact that the cartage business

is entirely in the hands of the railroads themselves; it is the ordinary feature of every day transit in England, and contrasts most favorably with either the United States or the Continent of Europe —a system of small lots at great speed.

In considering the magnitude of the work thus involved, both indoors and out, a thought should be given to what is often called the "retail" character of British trade. The quick services afford the wholesaler, the retailer or the consumer such facilities for directly satisfying their requirements in a few hours that only small stocks and storage are needed. This has accentuated the growing tendency to small shipments, and the instructive analysis from Pratt's "Railways and Their Rates," which follows, of the weights of consignments forwarded by freight trains from the Camden and Broad street (London) depots of the North-Western Company in the course of a single day, illustrates pretty clearly the amount of handling necessary for only a small tonnage. The total forwarded weight dealt with at the two depots on the date in question was 1,358 tons of 2,240 lbs., giving an average weight per consignment of 284 lbs.

Weights.	No. of consignments—Camden Goods Depot.	No. of consignments—Broad St. Goods Depot.	No. of consignments—Total.	Percentages—Broad Camden.	Percentages—Broad St.	Percentages—Total.
Not exceeding 28 lbs...	419	827	1,246	12.12	11.41	11.64
" " 42 " ..	252	473	725	7.28	6.53	6.77
" " 56 " ..	514	841	1,355	14.86	11.61	12.66
" " 70 " ..	173	407	580	5.00	5.63	5.42
" " 84 " ..	244	404	648	7.05	5.58	6.05
" " 98 " ..	111	242	353	3.21	3.34	3.29
" " 112 " ..	328	531	859	9.19	7.33	8.02
" " 224 " ..	591	1,506	2,097	17.08	20.79	19.59
" " 336 " ..	288	676	964	8.32	9.33	9.01
" " 448 " ..	168	380	548	4.86	5.24	5.12
" " 560 " ..	77	257	334	2.23	3.55	3.12
" " 1,120 " ..	160	456	616	4.62	6.29	5.75
" " 1,680 " ..	53	126	179	1.53	1.74	1.67
" " 2,240 " ..	27	38	65	0.78	0.52	0.61
" " 2 tons.....	33	57	90	0.95	0.79	0.84
" " 3 "	13	15	28	0.38	0.21	0.26
" " 4 "	9	9	18	0.26	0.12	0.17
Total	3,460	7,245	10,705	.....	.....	.....

This feature may be still more clearly seen from the following table, which shows the business done at North-Western freight depots at three important provincial centers as well as at the Broad street (London) depot.

From	Tons, of 2,240 lbs.	Consignments—No. of.	Consignments—Weight.	Packages—No. of.	Packages—Av. w't.
Curzon Street, Birmingham	1,615	6,110	592 lbs.	51,114	70 lbs.
Liverpool Stations	3,895	5,049	1,728 "	79,513	110 "
London Road, Manchester..	1,341	5,522	544 "	28,277	106 "
Broad Street, London.....	906	6,201	327 "	23,067	88 "

The traffic in smaller parcels taken on passenger trains, in which the North-Western has an enormous traffic, will be discussed in a subsequent paper. In many ways the inhabitants of the United Kingdom, and especially the trading population, owe gratitude to their well-worked railroads, but in nothing more than the thoroughness with which they undertake the whole office and incidentals of transportation, by either passenger or freight trains, with as little trouble to sender and receiver as would be involved in a transaction over the counter.

The Roadmasters' Convention.

The Roadmasters and Maintenance of Way Association held its twenty-fourth annual meeting at the Sherman House, Chicago, November 13 and 14. President C. Buhrer (L. S. & M. S.) was in the chair and about 50 members were in attendance. Mayor Dunne, of Chicago, delivered the address of welcome, to which Secretary C. E. Jones made response. Fifteen new members were added.

The committee reports and papers presented for discussion were: "Best Method of Maintaining Track for the Tonnage and Speed of To-day"; "Tie Plates"; "Wood, Metal and Combination Ties"; also the subject, "What Can Be Done to Induce Young Men to Enter the Track Service and Remain Long Enough to Enable Them to Take Charge of Track as Foremen?" which was assigned for committee work, but on which there was no report, was discussed briefly. In addition, Mr. E. E. R. Tratman (*Engineering News*) read a paper on "The Construction and Maintenance of Track in Tunnels," which he explained was largely made up of matter which has already appeared in his journal.

The most important report, and the one receiving the most discussion, was the one on "Best Methods of Maintaining Track for the Tonnage and Speed of To-day." It is reprinted practically in full on another page. The reports on tie plates and on ties were briefly discussed; also, as already noted, the matter of track labor. Following the discussions of papers and reports a novel procedure was introduced. Representatives of the supply houses having exhibits at the convention were invited to come before the meeting and explain the character and merits of their devices. Quite a number took advantage of the opportunity.

The officers for the ensuing year are: President, C. H. Cornell (C. & N.-W.); First Vice-President, J. W. Guffy (A., T. & S. F.); Second Vice-President, John Kennedy (B. & O.); Secretary and Treasurer, W. E. Emery (C. & N.-W.). A. E. Hanson (C. & N.-W.) was elected to fill an unexpired term in the Executive Committee. Standing Committee on New and Improved Appliances, C. E. Jones (C., B. & Q.) and Jas. Sweeney (C. & E. I.). The next convention will be held at Chicago.

Following is a list of the exhibits:

American Steel & Wire Co., Chicago.—Wire fencing.

American Trackbarrow Co., Lowell, Mass.—Models of trackbarrow, pony car and timber truck.

American Valve & Meter Co., Cincinnati, Ohio.—"Economy" switchstands.

Atlas Railway Supply Co., Chicago.—Atlas rail joints, braces, tie plates and switchstands.

B. B. Fence Co., Peru. Ind.—Fence stays and fence posts.

Belle City Malleable Iron Co., Racine, Wis.—L. & S. anti-rail creepers, joint tie holders and Murray tie spacing and straightening jacks.

Buda Foundry & Manufacturing Co. and Paige Iron Works, Chicago.—Ramapo switchstands, hand cars, track levels and gages, semaphore stands, jacks, drills and special track-lining jack.

C. Buhrer, Sandusky, Ohio.—Buhrer new improved I-beam type steel tie with wooden cushion and insulation blocks.

Chicago Steel Tape Co., Chicago.—Tapes, leveling rods and lining poles.

Cleveland Frog & Crossing Co., Cleveland, O.—Prentice anti-rail creeper.

Cook's Railway Appliance Co., Kalamazoo, Mich.—Track jacks, track drills, tool grinders, and cattle guards.

Dressel Railway Lamp Works, New York.—Switch and signal lamps.

Louis Dunn, St. Paul, Minn.—Dunn's frog and switch indicator and blueprints showing the Dunn safety and the Dunn-Strawhorn switch adjuster.

Fairbanks, Morse & Co., Chicago.—Track jacks, gasolene section car, velocipedes and track supplies.

Grip Nut Co., Chicago.—Samples of grip nuts.

Hayes Track Appliance Co., Geneva, N. Y.—Lifting derails and pivot derails with target stands.

Hussey-Binns Shovel Co., Pittsburg, Pa.—Shovels, spades and scoops.

O. F. Jordan, Chicago.—Model of ballast spreader.

Kalamazoo Railway Supply Co., Kalamazoo, Mich.—Hand and velocipede cars, track drills, gages, levels and jacks, wheels and axles.

Locomotive Appliance Co., Chicago.—Smith derailing switches, Freeland automatic derailing switches, Newton wrecking frogs and Newton divided frogs.

Luther Bros. Company, North Milwaukee, Wis.—Grinding machines.

Marshall & Dunn, St. Johns, Mich.—Model of boltless rail joint.

McCord & Company, Chicago and New York.—Model of Gibraltar bumping post.

McMyler Manufacturing Co., Cleveland, Ohio.—Odenkirk switchstand and Economy separable switch points and lock cranes.

National Lock Washer Co., Newark, N. J.—Nut locks, and samples showing efficiency.

Pennsylvania Steel Co., Steelton, Pa.—"New Era" and "Century" switchstands, semaphore switchstands with disappearing blade, "Manard" frogs, and track material.

Quincy, Manchester, Sargent Co., Chicago.—Bonzano rail joint, Q. & C. rail anchor, elastic nut lock and Cafferty tie tongs.

Rail Joint Company, New York.—Samples of Continuous, Weber and Wolhaupter standard rail joints. Insulated joints and step joints.

Railroad Supply Company, Chicago.—Tie plates, Stanford bumping post, and railroad supplies.

Railway Specialty & Supply Co., Chicago.—Smith improved lock nut.

Ramapo Iron Works, Hilburn, N. Y.—Safety split switches and automatic switchstands.

Joseph T. Ryerson & Sons, Chicago.—Working model of Ryerson flue-cleaning machine; Simplex track and car jacks.

Van Wormer & Moudy, West Unity, Ohio.—Loose-pin nut lock.

Western Association of Inventors and Patent Development Co., Corona, Cal.—Model showing method of railroad construction with ties parallel with rails and literature describing same.

A. J. Wilson, Chicago.—Nut locks.

Single Track Train Operation on the Wheeling & Lake Erie.

The accompanying photograph shows graphically the extra and regular trains run on September 2, 1906, on the main line of the Wheeling & Lake Erie between Toledo and Steubenville, including a specially busy stretch of single track line. The following tables sum up the information contained in the chart:

	Eastbound.	Westbound.	East & Westbound.
Total No. trains, (helpers and short runs)	85	75	160
Total No. through freight trains.....	34	30	64
Total mileage of through freight trains...	2,250.1	2,101.1	4,351.2
Total hours, through freight trains on road	257:08	261:28	518:36
Total hours delay to through freight trains	105:27	115:41	221:08
Av. speed, through freights, bet. terminals	8.7	8.0	8.4
Av. speed, through freights, while moving	14.8	14.4	14.6
Total No. of cars handled on through freight trains.....			2,612
Average No. of cars handled on through freight train, per train.....			42.3
Total No. meeting and passing points (Huron Junct'n-Pittsburg Junct'n)			296
Average No. of cars handled on through freight trains, per train.....			42.3
Least No. meeting or passing points, any one hour.....			6.0
Greatest No. meeting or passing points, any one hour.....			21.0

It will be observed that the time spent in delays on through freight runs averaged a little over three minutes per mile run. Daily records for a period of two years on different divisions of the Southern Pacific lines, showed that the time actually consumed in stops on freight runs having physical characteristics similar to the Wabash lines east of Toledo varied from thirty seconds to one minute per mile run on single track line, according to density of traffic. The very much higher figure shown on the Wheeling & Lake Erie, three times that on the Southern Pacific, is due to the congested condition of the line.

While there is no information available showing the time actually consumed by freight trains on a double track line, which, of course, would be affected by the number of fast passenger trains which freight trains running in the same direction would be required to clear, it is reasonable to assume that the delay on a double track line under average conditions would not be greater than on single track line under average conditions, namely, one minute per mile run.

Assuming that the line between Pittsburg Junction and Huron Junction were double track, the time allowance for stops on the 124

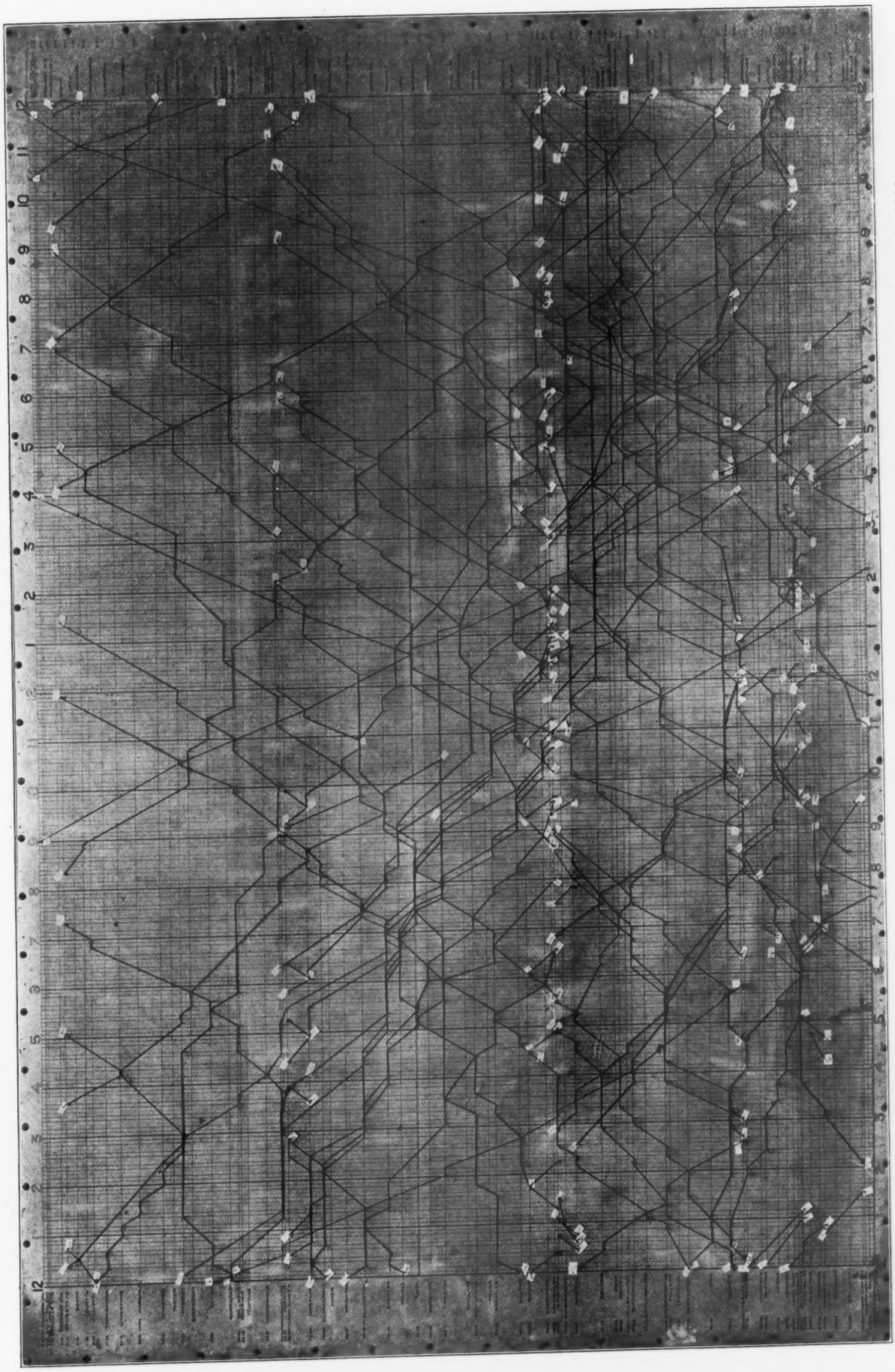


Chart Showing Extra and Regular Trains on Wheeling & Lake Erie Between Toledo and Steubenville on Sunday, September 2, 1906.

miles would be two hours and four minutes, which would seem to be ample. On this basis, the delay of 221 hours, 8 minutes, shown under present conditions, would become 72 hours, 30 minutes, a saving of 148 hours, 37 minutes, and as this saving of time would readily be converted from "delayed" to "moving" time, the average speed of through freight trains between terminals would become 11.8 miles an hour instead of 8.4 miles an hour as now. Yet the actual running time of trains need be no faster than at present. Furthermore, overtime payments now average about $12,000 a month in train service, and probably would also be reduced in the same proportion as delayed time, or a saving of about $8,000 a month on this item.

The increase in the speed of through freight trains between terminals would mean a gain of 1,753.48 train miles on the particular day shown on the chart. The average earnings per freight train mile for September were $3.21. Applying this to the increased train mileage (1,753.48 train miles) the earnings on this particular day would be increased $5,629, and as this is only an average day's business, the annual gross earnings would be approximately increased $1,500,000. Allowing 60 per cent. for operating expenses, the net earnings would be $600,000, and this amount, capitalized at 5 per cent., would be equivalent to earning interest on $12,000,000. At the same time the road would be getting the benefit of a double track, which would enable it to increase its volume of traffic fully three times. It will be seen that if with a double track line there were an average movement of 11.8 miles an hour between terminals, instead of 8.4 miles an hour, which is not an unreasonable expectation, this result alone would increase the capacity of the present car and locomotive equipment over 40 per cent.

The chart shows considerable delay to westbound trains at Bolivar and Navarre and to eastbound trains at Sherwood, due to inadequate yard facilities at Columbia, the principal intermediate freight terminal, necessitating holding out trains until this yard can be relieved. When the new 2,000-car yard at Brewster, now in process of construction on the 22-mile cutoff line from Orrville to Bolivar, is completed, the delay at Columbia yard will be entirely done away with. The estimate of the cost of double track between Huron Junction and Pittsburg Junction, including quite a number of line and grade changes to improve alinement and to attain a 0.4 per cent. maximum grade eastbound and a 0.6 per cent. maximum grade eastbound, is $3,404,550, to which should be added about $1,000 per mile for 124 miles to cover electric automatic block signals to bring the road strictly up to modern practice. For this information we are indebted to B. A. Worthington, First Vice-President and General Manager of the Wheeling & Lake Erie and the Wabash Pittsburg Terminal.

The Railroad Gages of India.*

The subject of the railroad gages of India was discussed at the Institution in 1873, and again, after an interval of 16 years, in 1889. A similar interval has now elapsed, and the present seems to be an appropriate time to review what has been done since the latter date, and to examine the possibilities of gradually attaining uniformity of gage, and the advantages to be obtained thereby. The questions which naturally arise are: (1) whether the cost and

*From a paper presented before the Institution of Civil Engineers by Sir Frederick R. Upcott.

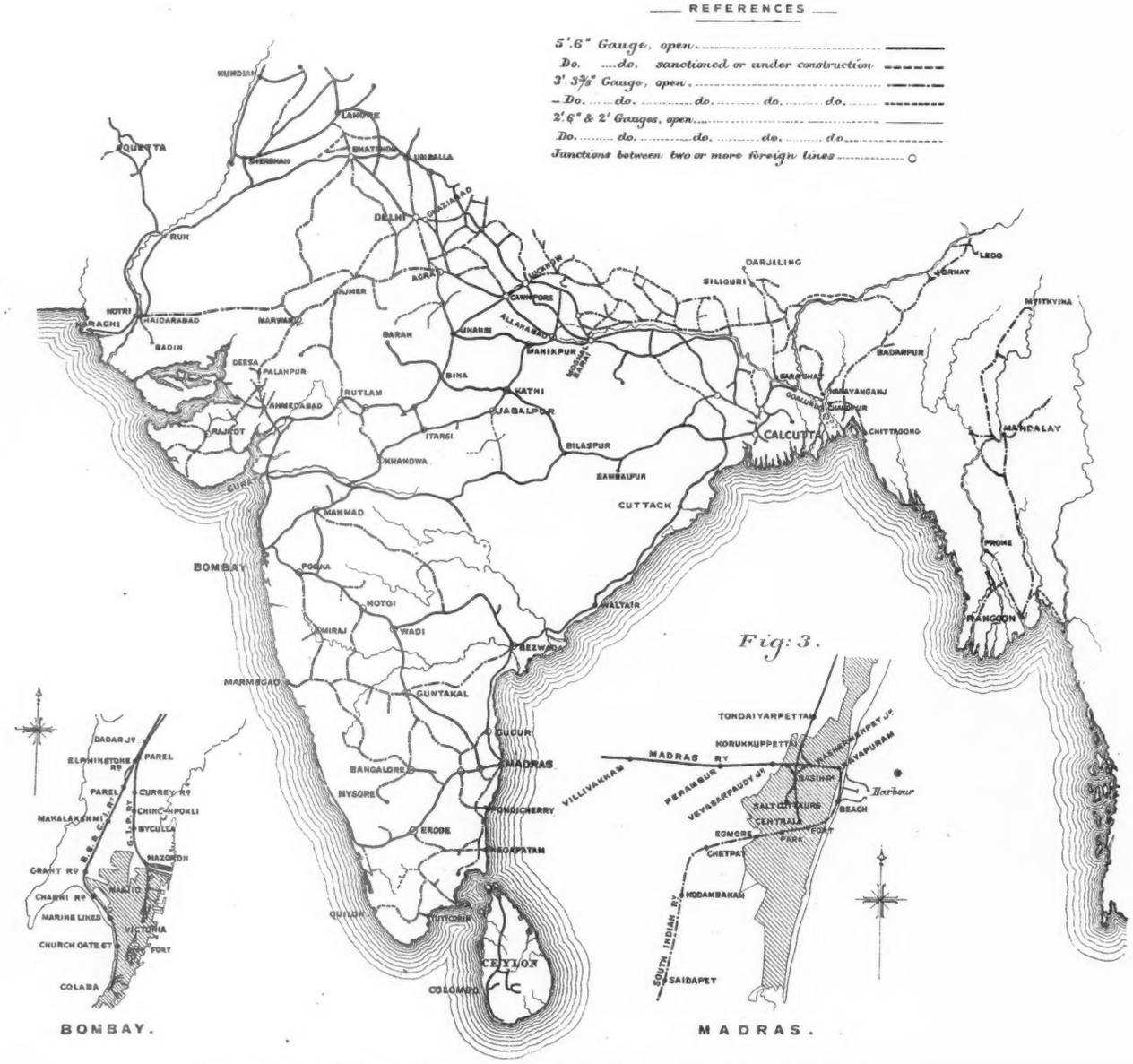


Fig. 3.

Map of Indian Railways Showing Present and Proposed Lines of Different Gages.

confusion which will necessarily accompany gradual conversion outweigh the advantages of uniformity; and (2) whether the growing needs of traffic may not be met by continuation and extension of different gages, treating each case on its merits, without attempting to establish any definite scheme.

In examining these questions it is hardly necessary to take into account the countries bordering on India which may in the future connect with the Indian railroad system, because Russia and China have adopted gages differing from those in India, and Persia has only a few miles of railroad at the present time. India is a vast country, and the bulk of its imports and exports are carried by sea. Moreover, its internal trade is very large, and its overland trade with these countries can hardly become of sufficient importance to warrant the adoption of a gage differing from those now in existence in India.

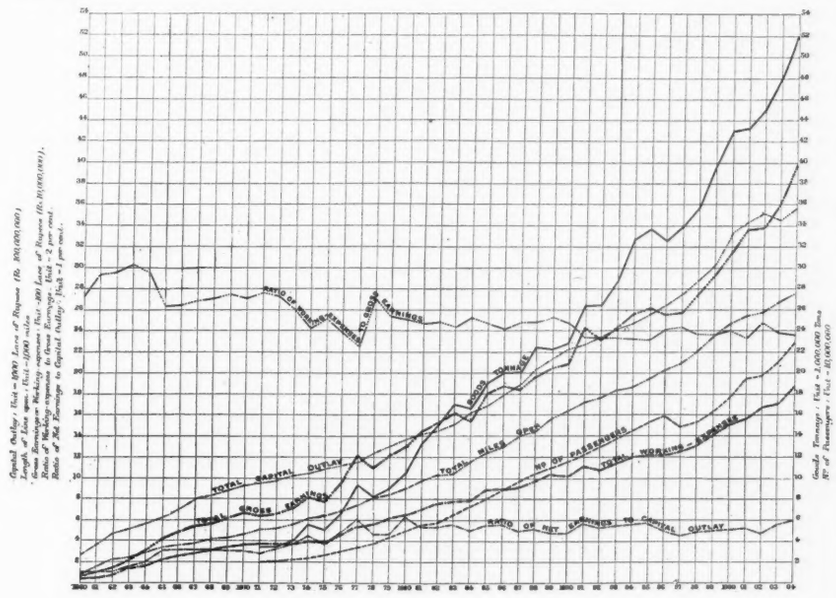

TOTAL CAPITAL OUTLAY
TOTAL GROSS EARNINGS
TOTAL MILES OPEN
NO. OF PASSENGERS
TOTAL WORKING EXPENSES
RATIO OF NET EARNINGS TO CAPITAL OUTLAY
RATIO OF WORKING EXPENSES TO GROSS EARNINGS

Chart of Principal Operating Statistics of Indian Railways.

The policy which was formulated in the early seventies, and reiterated at the close of 1888, of adopting two gages and restricting them to certain defined areas, has not been rigidly adhered to, the pressure of trade requirements and of rival interests having resulted in encroachments by each on the other's territory, induced by the necessity of linking groups of railroads of similar gage. Until 1890 the area served by the meter-gage lines was fairly well defined, being limited to the country north and east of the Ganges river, starting from longitude 80 deg. E., the whole of Burma, Rajputana and Gujrat, and the country south and west of the standard-gage line connecting Bombay and Madras; but by that time the meter-gage lines had gradually increased in efficiency with heavier and larger rolling stock and permanent way, so that they passed out of the category of light lines. On the other hand, the later standard-gage lines were built at less cost per mile than the earlier ones, and thus it became a still more difficult question to decide which gage should be adopted in any given case, the difficulty being accentuated by the very reasonable demands of the meter-gage lines to obtain access on their own gage to all the large centers of trade near them on the standard-gage lines, as well as to be linked with adjacent meter-gage systems, and in some cases to obtain connection with the seaports. The result has been that, in giving effect to some of the demands of the meter-gage lines, the standard-gage lines have been crossed at many places, and the gage that was originally intended to feed the standard-gage lines has become competitive; this, however, may be held to have actually resulted in benefit to the country and to trade, rather than the reverse, as has been often asserted by those who deprecate rivalry in the great arteries of traffic.

The present result is that at the close of 1903 there were in India 14,477 miles of standard, or 5-ft. 6-in. gage; 11,421 miles of meter or 3-ft. 3⅜-in. gage; 796 miles of 2-ft. 6-in. gage, and 262 miles of 2-ft. gage, open to public traffic, making a total of 26,956 miles; while 1,162, 1,273, 575 and 113 miles, respectively, were under construction and sanctioned. To a large extent the areas originally set apart for the meter-gage lines have been fairly well preserved, although, as was inevitable, certain connections have been made between the systems served by the meter-gage lines. Thus the meter-gage lines north of the Ganges have been joined with the meter-gage systems of Rajputana on the west and with the Assam meter-gage system on the east, while the Gujrat meter-gage system has been joined to that of Rajputana. The Rajputana system has approached the seaport of Karachi and may press for the short extension to that port, although there is already a double standard-gage track between Kotri and Karachi. An extension of the meter-gage line from Khandwa to Hotgi appears likely to be necessary in the near future, to link up the southern and northern meter-gage system; while the meter-gage line along the Godavari valley was undertaken by the Nizam's Government with a view to opening out that country as economically as possible, instead of laying down a light standard-gage line. Of the 2-ft. 6-in. and 2-ft. gages, now reaching a total length of 1,058 miles, it may be said that the success of the first two lines on these gages, the Darjiling and the Barsi lines, both constructed by private companies, not only drew the attention of the military authorities to the capabilities of a small gage for serving hilly tracts at a reasonable cost, to act as pioneer lines for the standard gage, but has also led to other lines being started as tramways which have eventually developed into railroads. These small-gage lines do not, in general, serve

TABLE I.—STANDARD-GAGE RAILROADS, 1903.

Railroad.	Mileage. Miles.	Cost per mile.	Return on capital. Per cent.	Per cent. of working. Per cent.	Average: Cost of carriage per pass'ger-mile. Pence.	Average: No. of passengers per train. No.	Average: Charge per ton-mile. Pence.	Average: Cost of carriage per ton-mile. Pence.	Average: Weight per train. Tons.	Average: Percentage freight to gross weight of train. Per cent.	Average: Gross earnings per mile per annum.
East Indian	2,231	£15,000	9.4	34	0.06	210	0.35	0.12	240	43	£2,200
East Bengal	278	18,000	6.4	54	0.11	188	0.39	0.31	150	34	2,452
Oudh and Rohilkhand	1,106	7,800	5.3	49	0.10	155	0.42	0.21	137	33	800
Great Indian Peninsula	2,745	13,000	7.7	51	0.13	131	0.54	0.26	145	25	1,378
North Western	3,744	9,600	4.8	49	0.09	176	0.42	0.22	161	40	1,208
Bengal-Nagpur	1,667	8,900	3.0	54	0.09	212	0.39	0.23	138	36	582
Madras	1,400	9,100	3.6	58	0.11	233	0.56	0.35	107	21	827
Bombay Baroda and Central India	825	13,000	5.9	50	0.13	221	0.66	0.29	262	43	1,590
Total	13,996	.....	...	...	....	....	....	....	....	..	.....
Average	.....	£11,800	5.7	50	0.10	191	0.46	0.25	167	34	1,380

TABLE II.—METER-GAGE RAILROADS, 1903.

Railroad.	Mileage. Miles.	Cost per mile.	Return on capital. Per cent.	Per cent. of working. Per cent.	Average: Cost of carriage per pass'ger-mile. Pence.	Average: No. of passengers per train. No.	Average: Charge per ton-mile. Pence.	Average: Cost of carriage per ton-mile. Pence.	Average: Weight per train. Tons.	Average: Percentage freight to gross weight of train. Per cent.	Average: Gross earnings per mile per annum.
Bengal North West	1,418	£5,300	6.3	43	0.06	208	0.49	0.19	101	42	559
South Indian	1,249	4,600	8.5	39	0.06	302	0.60	0.28	79	40	688
Burma	1,323	6,250	4.0	61	0.12	209	0.59	0.42	73	35	684
Eastern Bengal	732	6,250	5.6	50	0.12	194	0.63	0.36	83	36	689
Southern Marhatta	1,646	5,650	2.5	62	0.11	185	0.57	0.37	76	38	387
Rajputana-Malwa	1,871	5,000	7.6	50	0.10	240	0.55	0.28	128	47	792
Jodhpur-Bikaner	824	1,700	6.6	50	0.10	187	0.61	0.29	81	38	222
Rohilkhand-Kumaun	280	3,000	7.0	48	0.10	166	0.56	0.30	87	40	432
Total	9,343	.....	...	...	....	....	....	....	....	..	.....
Average	.....	£4,750	6.0	50	0.096	211	0.57	0.31	88	39	557

meter-gage lines, but have been built as continuations of, and feeders to, the standard-gage lines.

The tables given herewith, which have been compiled from the Railway Administration Report for 1903, present, so far as statistics can help to solve the problem, a fair basis for comparison of the relative merits of the standard and meter-gage systems. It is not claimed that an exact comparison can be drawn between them, because the conditions are not entirely similar; the physical nature of the country varies greatly, and strategic considerations have often compelled the adoption of a more expensive line than the commercial importance of the country justified. Nor is it suggested that the government could, under the numerous contracts entered into with companies for working state-owned lines, carry out any sudden or drastic change; any approach to uniformity that may be possible and desirable must of necessity be gradual. It may also be noted that the question of actual profit or loss to the Imperial government does not enter into the scope of the present inquiry, because, although the Indian railroad system does now yield a handsome profit to the government—which is the owner of nearly the whole of it—yet, owing to the plan originally adopted of guaranteeing sterling interest on lines since purchased, to the fluctuations of silver, to the premiums paid on purchase of the older lines, and to the provision, for its own lines, of capital raised partly by borrowing at various rates of interest and partly from the general revenues of the country, it is very difficult to calculate closely what may be called the fixed charges. Suffice it to say that 4 per cent. is generally accepted as approximately correct.

For the purpose of comparing the leading features of the two gages, the eight principal lines on each gage have been selected, and various particulars relating to them are shown. In making comparisons there are certain facts to be remembered: first, that so far all the meter-gage lines are single tracks, whilst 1,360 miles, or about 9 per cent., of the standard-gage lines are double tracks; secondly, that the branches to the meter-gage lines, especially north of the River Ganges, are much more numerous than those to the standard-gage lines; and thirdly, that the coal fields are served almost entirely by standard-gage lines, as is shown by the fact that in 1903, whilst the standard-gage lines carried 7½ million tons of coal, the meter-gage lines carried only the insignificant total of 112,000 tons. The year 1903 has been taken, not only because it is the most recent for which complete statistics are available, but also because some of the meter-gage lines had nearly arrived at their maximum capacity on a single track. The statistics have been compiled to exhibit in as fair a manner as possible the comparative value of the gages. The author does not claim that the question laid before the profession can be decided by figures; there are so many circumstances which have to be taken into account that it seems almost an insoluble problem. So far, the evil of the two gages has not been so great as was anticipated, but there is a feeling among many whose knowledge of the subject entitles them to be heard, that the confusion will grow from year to year, unless some more definite policy is adhered to than that which has been followed during the last 30 years. It is considered that there is a distinct danger lest the whole continent may be covered with a network of lines, of three different gages; and that the meter-gage and the 2-ft. 6-in. gage, originally introduced on the plea of cheapness and lightness, will, in course of time, be so strengthened that they will be able to carry a traffic that would almost support the standard gage.

(To be continued.)

TABLE III.—THOUSAND PASSENGER-MILES AND THOUSAND TON-MILES DURING 1903.

Railroad.	Thousand passenger-miles.	Thousand ton-miles.
Standard Gage.		
East Indian	1,417,665	2,227,443
Eastern Bengal	216,199	153,624
Oudh and Rohilkhand	394,233*	257,503
Great Indian Peninsula	874,084	1,223,607
North Western	1,183,232	1,315,489
Bengal-Nagpur	415,176	362,087
Madras	476,766	283,145
Bombay, Baroda and Central India	405,059	294,571
Average per mile of track	385	437
Meter Gage.		
Bengal North Western	458,027	213,814
South Indian	587,977	149,265
Burma	386,051	181,569
Eastern Bengal	213,179	111,135
Southern Marhatta	263,501	162,724
Rajputana-Malwa	605,676	414,581
Jodhpur-Bikaner	82,581	42,221
Rohilkhand-Kumaun	50,740	28,162
Average per mile of track	283	140

Remarks:—Nearly 9 per cent. of these lines are double track.

Remarks:—All these lines are single track.

TABLE IV.—AVERAGE SPEEDS AND AVERAGE GROSS WEIGHT OF TRAINS DURING 1903.

Railroad.	Average through speed per hr.			Average gross weight of trains.		
Standard Gage.	Passenger, Miles.	Goods. Miles.	Mixed. Miles.	Passenger.* Tons.	Goods. Tons.	Mixed.* Tons.
East Indian	20	14	17	197	487	240
Eastern Bengal	19	15	14	173	422	217
Oudh and Rohilkhand	29	13	18	185	333	225
Great Indian Peninsula	27	13	13	157	351	...
North Western	21	12	15	205	330	250
Bengal-Nagpur	26	11	17	197	332	340
Madras	26	12	10	151	348	276
Bombay, Baroda and Cent. India.	21	10	14	162	562	246
Average	23	12	15	178	396	256
Meter Gage.						
Bengal North Western	17	10	12	151	182	163
South Indian	18	10	12	85	152	167
Burma	19	11	13	131	166	174
Eastern Bengal	19	11	13	112	225	143
Southern Marhatta	16	7	12	95	273	212
Rajputana-Malwa	18	10	14	105	251	138
Jodhpur-Bikaner	19	11	13	93	176	117
Rohilkhand-Kumaun	17	10	14	Not furnished.		
Average	18	10	13	110	204	159

*For the purposes of these tables passengers are taken as weighing, with luggage: First class, 0.10 ton; second class, 0.08 ton; third class, 0.06 ton.

TABLE V.—THOUSAND PASSENGER-VEHICLE MILES AND THOUSAND GOODS-VEHICLE MILES DURING 1903.

Railroads.	Thousand passenger-vehicle miles.	Thousand goods-vehicle miles.	Railroads.	Thousand passenger-vehicle miles.	Thousand goods-vehicle miles.
Standard gage.			Meter gage.		
East Indian	119,480	304,185	Bengal N. Westn	50,569	58,386
Eastern Bengal	17,447	30,628	South Indian	40,230	39,527
Oudh and Rohilkhand	36,610	50,033	Burma	38,800	56,643
Gt. Indian Penin.	103,370	215,820	Eastern Bengal	21,171	35,328
North Western	106,008	219,640	Soth'n Marhatta.	30,218	47,088
Bengal-Nagpur	37,893	58,368	Rajputana-Malwa.	60,882	97,554
Madras	37,396	59,727	Jodhpur-Bikaner	9,488	12,490
Bombay, Baroda and Cent. India	29,342	44,738	Rohilkhand-Kumaun	5,912	7,486
Average	60,943	122,892	Average	32,159	44,313

METHOD OF CALCULATING COST PER PASSENGER-MILE AND PER TON-MILE.

The average cost per passenger-mile and per ton-mile is calculated by dividing the working-expenses in the ratio of the gross ton-mileage of freight and of dead load, assuming the weights of the passengers, with luggage, to be: First class, 0.1 ton; second class, 0.08 ton; intermediate and third class, 0.06 ton. For example, take the East Indian Railroad passengers for 1903, in thousands:

First class	10,550 x 0.1 ton =	1,055
Second class	28,277 x 0.08 ton =	2,262
Intermediate class	102,655 x 0.06 ton =	6,159
Third class	1,276,183 x 0.06 ton =	76,571
		86,047
Add other coaching traffic, parcels, etc., in ton-miles		21,880
		107,927
Total dead weight in ton-miles		1.836,741
Total coaching		1,944,668
Goods total freight in thousand tons		2,227,442
Goods total dead weight in thousand tons		2,890,426
Total goods		5,117,868
Total ton-miles		7,062,536,000
Total working-expenses (in rupees)		233,63,000
Total gross receipts (in rupees)		713,80,000

Working expenses in ratio of gross receipts:—

749	22,929	$= \frac{1}{3.1}$
1,587	48,451	
2,336	71,380	
6,433	19,450	$= \frac{1}{3.63}$ ratio of ton-miles.
16,930	51,180	
23,363	70,630	

Then the total working expenses in thousands of rupees, namely, 23,363, divided in the ratio of the ton-miles, namely, 1,945 and 5,118, will give 6,433 and 16,930. If, however, the division be made on the gross receipts from coaching and goods, namely, 22,929 and 48,451, respectively, the ratio is—

	Coaching.	Goods.
	1	3.1
as against	1	3.63 in the former case.

The foregoing passenger weights give an average of 0.061 ton per passenger, which agrees fairly closely with the figure arrived at by Mr. Jeans, in his work on Railway Problems, namely, that for the purpose of ascertaining the proportion of working expenses due to passengers, as distinguished from goods, fifteen passengers may be taken to weigh 1 ton.

This method shows incidentally, as far as it is considered reliable, the ratio of paying load to dead load in carrying passengers and goods.

Best Method of Maintaining Track for the Tonnage and Speed of To-day.*

Foundation.—The committee recommends that more care be taken to prepare the foundation for roadbeds. Material of the soundest and hardest character or quality should be used, such as stone, natural soil, hard clay, slate, gravel, sand or cinders. Muggy, spongy, water-holding clay or quicksand should not be used. Where roadbeds are built on soft, water-holding clay or quicksand, not less than 3 to 4 ft. of sound, solid material should be placed on top of it. In soft cuts, containing spongy clay or quicksand the grading should be done low enough to allow at least 3 or 4 ft. of good ballast under the ties.

Foundations for tracks should be built so that every rainstorm will not affect the surface and line of the track. The committee has observed cases where good surface, which took months of hard work and large sums of money to prepare, was destroyed during heavy rainstorms. This result could have been avoided on a permanent roadbed. It would justify the first cost of building a permanent roadbed, as the expense of continually surfacing up low and uneven places is high; and besides uneven track is very annoying to high speed trains, and is also dangerous. Where the tracks are laid close to spongy clay and close to quicksand, if the grade will not permit of raising the track high enough, sufficient depth of material should be dug out at these places, and supplied with 3 to 4 ft. of good, clean stone ballast. In this way continuous settlement and uneven track can be avoided at these points.

Permanent roadbeds should be built 20 to 22 ft. wide, for single tracks, and 24 to 35 ft. wide for double track, on high fills, and the same width in cuts to make room for good surface side ditches. The wide banks on high fills will pay for themselves by being made broad enough to keep ballast and ties from going down the slope while unloading. The time spent from year to year in getting up ties, ballast and rails that have rolled down high banks is expensive, and it would more than justify the building of wide banks for roadbeds on high fills. The slopes on embankments, earth, should be built 1½ to 1, rock from 1 to 1½ to 1. In excavation earth should stand 1½ to 1, to 3 to 1, loose rock ½ to 1; solid rock ¼ to 1 within the limits stated. These ratios may be varied as existing conditions demand.

Drainage.—To have good permanent track it is absolutely necessary to have good drainage. All track and roadbed should be kept free from water. No water should be allowed to remain on roadbed or tracks. Drainage should be provided by open surface ditches and tile drains, as the existing conditions permit and demand. The committee recommends that more tile drain ditches be laid, but nothing smaller than 4-in. drain tile should be laid in them; larger drain tile is preferable for the roadbed and track drainage.

On roadbeds built on soft, water-holding material, cross drains should be provided to keep the roadbed dry. Careful drainage of cuts with drain tile will, to a great extent, avoid heaving of track in the winter time. Surface ditches should be kept clean, and all rubbish, grass and shrubbery should be cut from the bottom of the ditches at least once a year. Good outlets should be provided for drains so that the water can run away freely. The ditching on roads that have a great many cuts causes expensive maintenance, and great care should be taken to provide the proper slope for the banks in order to avoid sliding or washing. All slopes or cuts should be built to the proper slope for the material to keep it from sliding or washing down upon the track and ditches, and at times covering the track and mixing clay with the ballast, thereby doing a large amount of damage. The extra expense so caused would more than justify building the proper slope for the banks when the road is constructed.

All cuts should be provided with good surface ditches on top of banks. No water should be allowed to enter cuts. By good surface ditches on top of banks a large amount of sliding material can be avoided. In cuts drain-tile ditches should be laid on each side of the track, about 1 ft. from the end of the ties; on double track, drain tile should be laid between the two tracks, and cross drains provided about every 500 ft. Drain tile should be laid at least 2 ft. below the top surface of the ballast, on the roadbed, and covered with porous cinders for about 1 ft. Borrow pits along the tracks should be connected with the nearest water course. Material should not be borrowed to a greater depth than will permit proper drainage. Where water is standing near the track in borrow pits or other depressions that cannot be drained, the pit should be filled to sufficient depth to prevent the standing of water near the track.

Depth and Kind of Ballast.—On account of the increase in tonnage and speed in past years, the committee recommends broken or crushed stone durable enough to resist the disintegrating influences of the weather and climate where used. It should be hard enough to prevent pulverizing under the treatment to which it is subjected, and stone should be selected that will break in angular pieces when crushed. The maximum size of ballast should not exceed that of pieces which will pass through screens having 1½ to 2 in. holes. The minimum size should not pass through a screen having ¼ in. holes. For new roadbed the depth of ballast should not be less than 18 in., but on old roadbed, where gravel or cinder ballast has been used to a depth of 10 or 12 in. an additional 6 in. of stone ballast supplied under the ties will give good results. This class of ballast will be free from dust, which is a very essential point, as dust is very annoying to the traveling public during the summer season, when the weather is hot and the windows are left open. Gravel ballast, unless it is washed and the fine dust removed, will be more or less dusty, and besides, much of the gravel used is badly mixed with clay, and during wet weather gets soft and mushy, causing the track to get loose and out of surface. Gravel ballast cannot be worked sucessfully while wet. Stone ballast can be worked during wet weather as well as in dry weather. While stone ballast is harder to work than gravel ballast, it will maintain surface and line better than gravel and will make a more permanent roadbed.

Size, Length and Spacing of Ties.—The committee recommends 7 in. x 9 in. x 8½ ft. ties as the proper size to take care of and hold up the track under present traffic. It believes that by supplying more bearing surface outside of the rails better results will be obtained. The 8-ft. tie in almost universal use was of sufficient length until the heavy rolling stock came into use. The engines of to-day are much higher and wider than the engines of five or ten years ago, making them top heavy, and the track department is expected to, and must, maintain the track with ties of the same length as were used with lighter equipment and rolling stock. We would recommend as the proper spacing of ties of 8 in. face, 18 in. center to center; for 9-in. face, 20 in. center to center; shoulder ties at joints should be 16 to 18 in. center to center. This spacing would provide better bearing surface for the traffic of to-day. Ties should also be uniform in length, to supply an even bearing on both sides of the track.

Weight, Height and Pattern of Rail.—The committee recommends for steam railroads on heavy traffic lines, rails weighing 90 to 100 lbs. per yard, and from 30 to 33 ft. long. Rails weighing 90 to 100 lbs. per yard at this length will be heavy enough to handle and unload from cars and lay in track. The committee has observed that some of the failures of the pattern of rail now used are caused by the head of the rail being too wide for the web. A stronger web in proportion to the head of the rail should be provided to give sufficient support to the head of the rail and avoid splitting, or what is ordinarily called piping.

The committee considers a rail 5 in. high is high enough, on account of the danger of spreading track. The higher the rail stands above its base or bearing the stronger is the leverage on the same. When we consider the speed of trains as high as 70 to 75 m.p.h. with a 200-ton engine, swinging back and forth on the rails and striking a blow which it is impossible to figure, it stands to reason that the top of the rail should be kept within moderate height. The committee recommends that a rail with a 6-in. base and 5 in. height rolled in proportion, is a safe and proper rail to be used with the present rolling stock. The wide base would materially lessen the tendency of the rail to cut into the ties. It will give a larger and a more solid bearing surface, and with this design of rail there should be less spreading of track.

RENEWING TIES IN DIFFERENT KINDS OF BALLAST.

Stone Ballast.—If a general renewal can be made, the best result will be obtained by lifting the track with jacks sufficiently high after the stone has been removed from between the ties so that the old decayed ties can be removed without destroying the roadbed under the same, and then placing the new ties on the old foundation and resurfacing the track carefully and true. These ties should be carefully tamped with tamping picks. But when only two or three decayed ties are to be removed from under one rail and the track is in general good surface, it would not be justifiable to disturb the roadbed. In that case the cheapest and quickest way is to dig out for these ties so that they can be removed without disturbing the remainder of roadbed.

Gravel Ballast.—If a general renewal is to be made the best results can be obtained by lifting the track sufficiently high to remove the old ties without disturbing the roadbed, and permit the new ties to be carefully bedded. In this way the general surface of the track will not be disturbed. The new ties should be carefully tamped with shovels on the day they are placed in the track, and on the following day this track should be carefully resurfaced and all ties carefully tamped with tamping bars or picks. Where there are only from three to five ties to be removed in one rail length and the general surface is good it is not proper to raise the track, but the decayed ties should be dug out and the new ties placed on the old foundation, as existing conditions will permit. On roads with very heavy and fast traffic all track should be resurfaced and carefully tamped with tamping bars or tamping picks on the same day the ties are put in, for the reason that if the roadbed is dug deeper in some places than in others the tendency will be to settle unevenly, and result in rough and unsafe track for fast trains.

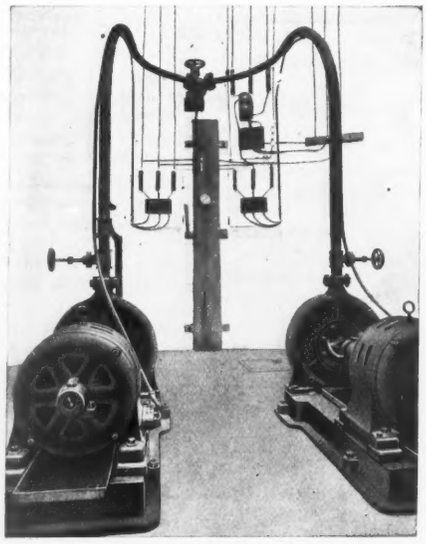
*A report presented to the Chicago convention of the Roadmasters' and Maintenance-of-Way Association, by a committee, consisting of C. Buhrer, chairman; T. Hickey and M. Burke.

Track of this kind should be resurfaced and tamped the second time in the course of eight or ten days, and all new ties and low places should be carefully retamped.

Surfacing or Tamping Track.—To have true and even track it should be raised to perfect level. Great care should be taken by the foreman in charge to raise the track level. Sighting boards should be used and set at high points in order that short sags can be taken out. All track should be carefully examined with a true level board before any raising is done in order to find out which side of the track is the higher. When this has been done and the track is in general good surface the low spots should be raised on the high side and the other side should be raised by using a true spirit level. It is of the greatest importance that both sides on tangents be on the same level. First it is necessary that the track be raised level. After the track is raised level it becomes necessary that the ties be tamped solid. In raising or surfacing up low places tamping bars or tamping picks should be used and all ties that have been raised should be tamped until they are solid. The hardest tamping should be done under the rail and on the outside and about 15 in. on the inside of the rail. From there to the center of the tie tamping should be done only about half as hard to avoid the track getting center bound. In light raising in stone ballast tamping picks are the proper tool to tamp with, but in gravel ballast tamping bars are preferable; however, it is well to use tamping picks to retamp all joint ties after using the tamping bar. The joint ties should be tamped the hardest.

Lining and Filling in Track.—In order to maintain good, true line it is absolutely necessary to have true and exact gage, and true and even surface. True line, true gage and true surface are the three essentials of perfect track. The best results can be obtained by lining track after the raising and tamping has been done. The raising and tamping of the track should be so arranged that the track can be properly lined over the portion of the track raised during the day, and the track properly filled in and then completely finished up by the time to quit work, so that the day's work will be entirely finished. The filling in of the track should be done in workmanlike manner. Ballast should be filled in solid between the ties, and in the center of the track level with the top of the ties. From a point under the rail to the end of the ties the ballast should be sloped from about ½ in. below the base of the rail to 2 in. below the top of the ties at the end. This will give the water free outlet. Tangents should be adjusted by throwing the track between summits, between curves or by throwing the curves to meet the tangents; or by partly throwing the curves and partly throwing the tangents, as may better suit the conditions. Centers should be set with a transit to insure accurate line.

Pump House.



Interior of Pump House.

Water Tank.

Adjustment of Curves with Consideration as to Easements.—It is recommended that easement curves should be as follows:

For speed not exceeding 30 m. p. h., on all curves exceeding 2 deg.

For speed not exceeding 60 m. p. h., on all curves exceeding 1 deg.

When higher speed is attained, on all curves exceeding 30 min.

Easement curves should be used between curves of different degrees in the same way that they are used between curves and tangents.

The length of the easement curve should be the same as the distance in which the curve elevation is run out; therefore, as the elevation of a curve depends not alone on the degree, but also on the speed of the trains, the length of the easement curve should vary in the same manner.

For ordinary practice a chord length equivalent to 100 ft. for each degree of variation in curvature is recommended.

Where the distance between curves will not allow this, or if for other reasons, a chord length of 25 to 30 ft. may be used.

For very high speed roads, a chord length equivalent to 150 ft. or more per degree of variation is recommended.

Any form of transition is satisfactory which gradually changes the degree of curvature and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as the distance in which the elevation of the outer rail is raised from zero to full elevation.

Any transition curve of the type of the Searles, Crandall, Holbrock, Talbot or the cubic parabola, which is susceptible of being run in by deflection or offset, is good for this purpose.

Elevation of curves with special consideration to the amount of the beginning and the end of the elevation as modified by the location of the curve and the condition of the traffic, will attain good results if the formulas which were expressed in our last Proceedings are followed. Since the elevation required is a function of, and depends on, the train speed, this speed is the first element to be determined in general as a matter of safety; the preference should be given to fast passenger traffic. The inner rail should be maintained at grade.

Automatic Electric Motor Driven Pumping Plant.

A successful induction motor-driven pumping plant for supplying railroad water tanks is in operation on the Lake Shore & Michigan Southern at South Bend, Indiana. The pumping outfit consists of two Worthington single-stage turbine pumps, each direct connected to a six-pole, 7½-h.p., three-phase, 440-volt General Electric Company induction motor. Two pumping sets are installed, so that in case one set fails, repairs can be made without shutting down the plant. Power for operating the induction motors is taken from the lines of the St. Joseph & Elkhart Power Company.

The pumping house is a round brick structure erected at the top of a concrete lined wall. The floor is of concrete, supported by I beams, and is ten feet below the level of the ground. On this the pumps are erected, the interior arrangement being shown in one of the illustrations. For keeping the pump room dry, four ventilating ducts are built into the wall of the pump house, the outlets appearing in the pilasters in the exterior view.

Each pump discharges water through a 2½-in. pipe connecting with a 4-in. main which leads to the supply tank. This tank is located at the side of the tracks about 100 ft. from the pumping station. The controlling device is arranged in the housing on the roof, the motors being started and stopped automatically by a small oil-switch operated by a float which has a vertical movement of about one foot. The difference in level in the tank corresponds to 3,000 gallons of water. This is the average amount taken by a locomotive and is replenished by the pumping set in about 25 minutes. The supply tank holds about 50,000 gallons and could supply fifteen locomotives within a few minutes if necessary. However, such a heavy demand will probably never be made, and in actual practice the pumps stand idle for the greater part of the time.

The Austrian State Railroads recently contracted for 1,252,000 cross-ties, for which they will have to pay about $800,000, or an average of 64 cents each. Less than a third are to be oak, two-fifths fir, more than a fifth larch, and very few pine and beech. All will be treated with preservatives after purchase.

Finished Repair Parts for Locomotives.

BY HARRINGTON EMERSON.

The work of a railroad repair shop may be divided into three classes: (1) The erecting floor work; (2) the machine work for engines on the erecting floor; (3) the manufacture of new engine repair parts or the repair of old ones—these parts either for engines already in the shop or for stock to be held until called for by the needs of the erecting floor. The importance of the first two are thoroughly understood by motive power officials. The third, which is fully as important, has not been worked out as completely.

In the following I shall treat on this from five sides:

1. The saving of engine delays possibly effected both in the general repair shop and in the roundhouse by having a supply of finished repair parts in stock ready to be applied at a moment's notice.
2. The necessary standardization of locomotive parts.
3. The determining of shop costs.
4. The storehouse side.
5. The possibility of buying manufactured repair parts in the open market.

The Saving of Engine Delays.—The value per day of engine service is reckoned on various roads from $15 to $35 per day, the average being about $25. Engines are delayed more often in the repair shop for want of material than for want of men, and this delay is increased still more if, after waiting days or weeks for material, time must still be taken to do the machine work. It is evident that with a complete stock of repair parts finished and ready to be taken from stock as called for, the delays due to backshop and roundhouse repairs can be cut down. Just how much is a matter of trial. In the largest locomotive manufacturing plant of the country only four days are allowed for the erecting or assembling of an engine after the parts are ready to be assembled. It may be expecting too much to cut down the time of engine overhauling to this figure, as the stripping or taking down of the old parts takes time. It does seem that if the manufacturer can erect an engine in four days from its component parts, the railroad repair shop should take down and replace worn parts in eight days. If the repair parts for a locomotive are all on hand and finished before the engine comes into the shop, the railroad is in the same condition as the manufacturer who has all his parts ready to assemble and then starts to erect his engine.

Standardization of Locomotive Parts.—Magazines and technical journals have been full of standardization articles. Every one realizes the importance of this without adding here another chapter to the literature on the subject.

Determining Shop Costs.—Costs are usually figured on the basis of material plus direct labor, with little regard to a suitable distribution of the extra charges or surcharges, such as power, supervision, spoiled work, interest on investment, depreciation of machinery, buildings, etc. The general feeling has been that in order to keep trains moving the engines must be put through the shop regardless of expense, and that the exact figuring out of costs would not make the work any better or cheaper. This is a mistake, as it is only by accurate records that we can tell what has been done and from these records draw conclusions as to the future course to be pursued.

Cost determination with surcharges is not as difficult as it would seem. On the average a man and machine cost, surcharges included, close to $1 an hour. This has been determined very accurately by a series of years in commercial establishments, and can be accepted as a reliable basis. When a shop contains many machines, some large and costly, others small and cheap, the average of 70 or 80 cents per machine can be distributed over the different machines, some being as high perhaps as $10 an hour, others as low as 10 cents, but averaging 70 or 80 cents. If there is no machine rate, as in erecting jobs, it is safe to add 100 per cent. to direct wages.

The surcharge or distribution of all general expenses in a machine shop is something that commercial establishments have been considering for years, and have worked to an accurate basis. There are few if any railroads that have given it much serious consideration, and there was no need that they should, for when one is taking from one pocket and putting into the other it does not matter much what is charged for the transaction. This is what takes place on a railroad. Rough material is purchased and finished, the final cost being figured as the labor added to the material, without the necessary adjustment of extra charge for all surcharges. It has not mattered if the final or "book value" was altogether too low, as the piece was simply passed from one department of the road to another, as from store to mechanical department, or from one division to another.

The Storehouse Side.—With the many classes of engines on our railroad systems the question arises whether it is economical to carry finished material for all classes. On a certain road having 125 classes of engines it was found that 12 principal classes covered 80 per cent. of the power. The policy of carrying material for these principal classes was followed out, a very much simpler proposition than attempting to carry material for all classes.

Custody and care of finished and repaired material is nothing new to the store department, as every railroad storehouse is now carrying material to meet the needs of tributary shop or district. It is a mere detail as to whether this material shall be carried in the rough or finished state. As material is carried in stock to avoid delays, it is important that it be as near finished as possible, thus still further shortening delays. Incidentally, certain engine classes should, as far as posible, be assigned to certain divisions, thus avoiding the duplication of repair supplies for the same class at many different points. On the other hand, when an engine class is transferred from one division to another, all material for that class should follow. Recently on a large system nearly $1,000,000 worth of issued material was inventoried and returned to stock. This material had accumulated largely because engines had been transferred to other divisions, but the repair and renewal parts had not followed.

The Possibility of Buying Manufactured Repair Parts in the Open Market.—There is a growing feeling among motive power men that a railroad cannot make locomotive material in its shops as cheaply as it can be bought. If it is advantageous to buy locomotives, would it not be wise to buy supplementary repair parts to be used on these same locomotives? Would any trouble be experienced in regard to repair work if on an order for ten engines, nine were bought set-up and the tenth received in unassembled pieces that could be used to replace parts of the other nine as their parts wore out or proved defective?

Transportation of passengers and freight is the principal business of a railroad. The manufacture of locomotive parts is merely one of the necessary detail complications that arises, and any method of getting rid of this detail and keeping busy at straight railroading should be tried out. Many railroads have tried with marked success the policy of centralizing their work at some large central shop and supplying all outlying shops and roundhouses with finished material from the central plant. This reduces the outside shops to mere repair points. Their material comes to them ready to be put in place, and all that is required, in overhauling an engine, as far as new parts are concerned, is to take down the old worn-out or broken pieces and replace them by new ones from stock.

It is found that the central shop manufacturing repair parts in quantities can get work out much cheaper than the local shop with poor facilities finishing the material one piece at a time as called for by engines. If this centralization is carried to its fullest extent, the work at outside shops is reduced to a minimum, and work at the central shop is increased to such an extent that it must certainly interfere with the rapid and regular overhauling of locomotives.

If it is found that the central shop manufacturing in quantities can reduce the cost of finished material, why cannot this same process be carried a step further and instead of manufacturing in the central shop, buy all material from highly specialized manufacturing plants? With a little encouragement in this line we should find manufacturers specializing on machinery to a greater extent than any railroad can afford, because the man who has a special machine and special methods for making one piece—a piston rod, for example—would not expect to confine himself to the needs of one road, but would offer to make piston rods for all roads of the country, which, with the great demand he would thus have for his one special article, would allow him to make large reductions in price.

A difficulty the railroads have when they try to manufacture is that the manufacturing of repair parts is carried on as a matter of secondary importance in their locomotive shops. This means that the locomotive repair shop is run for two purposes: (1) to repair engines and (2) to manufacture repair parts. This being the case, the manufacturing end is bound to suffer, as the output of engines is the most important thing, and if any engine work is called for from any machine, that machine will be stopped and a manufacturing job set aside to make way for an engine job coming from the erecting floor. To manufacture cheaply, all the duplicate parts of an order should be made at one time, but the continual changing of machines to make way for engine work prevents a cheap manufactured outout being obtained in the ordinary repair shop.

Repair shops should be run for two purposes only: Repairing engines and repairing repair parts. Finished material and repaired material should be furnished from stock. If a railroad deems it necessary to manufacture either locomotives or repair parts, it should be done in some shop under management and control separated from the regular repair work. Would it not be better to encourage manufacturers already equipped with necessary special machines to supply this manufactured material? If the railroad standardizes locomotive parts they can be bought in the open market from shops organized to produce at less cost these special articles. Manufacturers working under a competitive system are continuously forced to reduce manufacturing costs. Railroad shops, not

having the stimulus of competition, have no strong incentive to economy of manufacture.

In considering whether to buy material or not the cost must be looked into. It has been shown that railroads commonly figure costs in such a manner that their values, although in a way satisfactory when dealing between different departments of the same road, are of no use in comparing manufacturers' prices with railroad values. Manufacturers' prices compared with railroad "book values" may appear high, but everything considered, the highly specialized manufacturing plant should sell its output at a less figure than the ordinary railroad repair shop can produce the same.

From the foregoing the following conclusions are drawn:

1. Shop and roundhouse delays can be reduced by carrying finished repair parts in stock.

2. To compare railroad prices with the open market, or one shop with another, accurate costs must be determined.

3. Manufacturing of repair parts should be entirely separated from the repair of engines.

4. Manufacturers can produce repair parts more cheaply than a railroad, and with more prompt delivery.

The official statistics of the Russian railroads for the first quarter of 1906 show, compared with the corresponding quarter of the previous year, an increase of 1 per cent. in the number of passengers, of 2¾ per cent. in the tons of freight carried, and 1¾ per cent. in gross earnings.

Unit Costs of Railroad Building.*

IV.

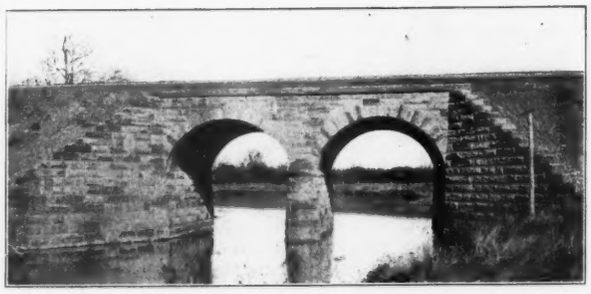
The first two articles of this series gave costs per mile for completed railroad lines in the East and in the Southwest; the third article, cost and quantities of broken stone ballast per mile for single-track, double-track and four-track lines on a railroad of heavy freight and passenger traffic in the East.

The following information covers the cost complete per mile of some of the new road built within the last few years by one of the through trunk lines east of Chicago. The construction includes a short low grade line, a branch to coal mines, new line in bituminous coal territory, a cut-off and a 50-mile low grade line for fast service in comparatively open country. None of the estimates of cost include real estate, stations, equipment or signals.

Line E.

Line E.

Line E.



Line E.

(A) LOW GRADE LINE IN EASTERN WEST VIRGINIA.

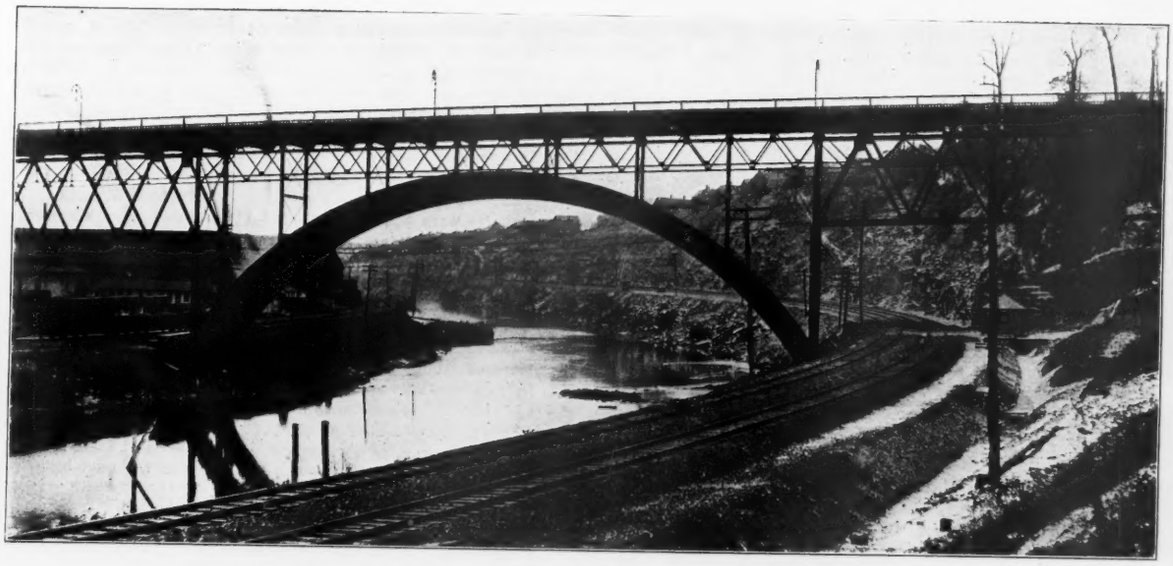
(1) Length of new railroad, 10.72 miles *single* track.

(2) Year built, 1903.

(3) Cost, including preliminary surveys, clearing right-of-way, roadbed, ties, rails, ballast, in shape for operation, but not including any real estate, stations, equipment or signals, $78,000 per mile.

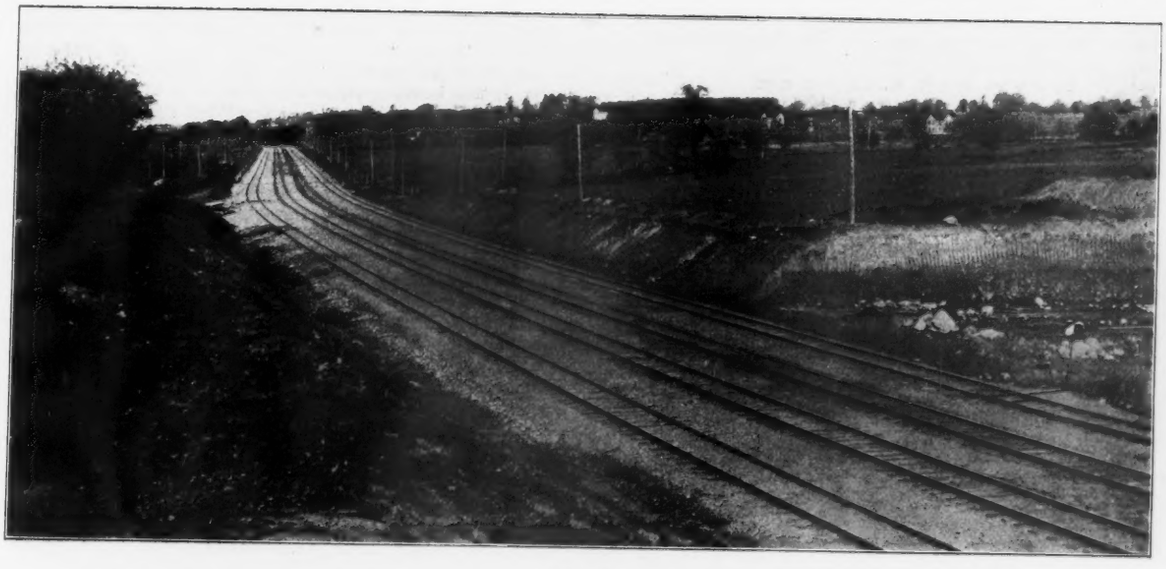
(4) Brief description of physical characteristics of country traversed: For two-thirds of the distance the line was excavated from sandstone, slate, shale and limestone, and the balance, limestone, clay and loam. The cuts were 24-ft. embankments 8 ft. wide.

*Previous articles in this series appeared in the *Railroad Gazette*, Sept. 7, Oct. 26, and Nov. 16, 1906.



Line E.

Line E.



Line E.

Standard masonry structures, stone ballast and 85-lb. rail were used.

(B) BRANCH LINE TO COAL MINES IN CENTRAL OHIO.

(1) Length of new railroad, 4.1 miles *single* track; 2.35 miles of sidings.

(2) Year built, 1903.

(3) Cost, including the items above mentioned in "A" and side tracks, $40,700 per mile.

(4) Brief description of physical characteristics of country traversed: Line crosses ravine and through summit by tunnel, single track, timber lined, 475 ft. long; thence along and down small streams to terminus at mines. Pipe culverts and timber trestles were used. Excavation consisted of earth and solid rock.

(C) NEW LINE IN SOUTH CENTRAL WEST VIRGINIA.

(1) Length of new railroad, 12.48 miles *single* track; one-half mile of sidings.

(2) Year built, 1903 and 1904.

(3) Cost, including the items above mentioned in "B," $40,000 per mile.

(4) Brief description of physical characteristics of country traversed: Line follows small river for 2.5 miles, then up a small run 4.4 miles, across summit and down another small run 2.7 miles to its mouth, then following small river 2.9 miles. The line along river is in a farming country slightly above the out-crop of the Freeport coal, but strikes the out-crop of Pittsburg coal about two miles above mouth of the first run. Follows this out-crop over the summit until it strikes the river again. The general surrounding country is rolling, with low divides.

(D) CUT-OFF IN EASTERN WEST VIRGINIA.

(1) Length of new railroad, 8.1 miles *double* track.

(2) Year built, 1902 and 1903.

(3) Cost, including items above mentioned and tunnel 4,120 ft. long, double track, arched with brick, $154,000 per mile.

(4) Brief description of physical characteristics of country traversed: This cut-off leaves main line, following up creek valley for two miles; thence into valley of small run, following stream to its source in range of high hills; thence pierces hills with tunnel 4,100 ft. long, comes to river opposite main line, crossing same at elevation of 70 ft. This line has 0.3 per cent. grade eastbound and 0.8 per cent. westbound, and was built to save distance. The present distance by main line is 17 miles, and by cut-off 6¼ miles, saving of 10¾ miles.

(E) LOW GRADE LINE IN NORTHEASTERN OHIO.

(1) Length of new railroad, 51.84 miles, *double* track; 25 miles of sidings.

(2) Year built, 1903, 1904 and 1905.

(3) Cost, including the items above mentioned in "B," $100,000 per mile.

(4) Brief description of physical characteristics of country traversed: This line passes through a thickly populated valley for about nine miles; thence through a rolling and prosperous farming country, plentifully supplied with streams. At several places deposits of muck earth were encountered, and in one case it was necessary to construct artificial support to carry the track. Line was located especially with a view to speed, safety and distance; consequently, it required an unusual amount of grading and masonry. Wherever it was at all practicable the road crossings were placed over or under. At numerous important street and railroad crossings separation of grades was made. Typical parts of this line are illustrated in the accompanying photographs.

Steam Versus Electric Operation of Trunk Lines.

BY JOSEPH MAYER, M. AM. SOC. C. E.*

It is here attempted to show by a single instance, which is typical of a great many others, what financial results may be expected from the change from steam to electric operation of trunk lines. The instance used is the Lake Shore & Michigan Southern from Buffalo to Cleveland. The writer's information in regard to present conditions is derived from the published report to the stockholders for the year 1905. This report refers to the whole system. The cost of steam locomotive operation of the assumed amount of traffic on the selected part of the line can be inferred from the published data with a fair degree of accuracy. For the purpose of this argument, an approximate estimate of the present amount of passenger and freight traffic is sufficient.

AMOUNT AND KIND OF TRAFFIC.

The number of passenger trains at present is given in the time-tables. There is in existence a competing parallel electric road which would undoubtedly be improved if steam locomotive operation were to be indefinitely maintained. The local passenger traffic, which has already suffered severely from this competition, would decrease still further. There are now approximately 28 daily passenger trains going over the line, four being local trains. The probable future traffic with steam locomotive operation is estimated at 26 daily trains for through passengers and two accommodation trains for local passengers. The average number of cars per passenger train is estimated at eight and the earnings per passenger-train car-mile are estimated at 24 cents. This gives, for steam locomotive operation, passenger-train earnings of $3,590,000. This includes $3,333,000 from through traffic and $257,000 from local traffic.

INCREASE IN PASSENGER TRAFFIC AND EARNINGS.

The tracks are very crowded with traffic, and it is believed that it would not be expedient to run single cars or cars with trailers. The traffic for the shortest distances will probably generally remain with the present competing line. By establishing frequent fast local trains, the passenger traffic for medium distances can be secured. The combined population of the two terminals is about 900,000, that along the line is about 180,000. It is estimated that, by the service hereafter described, the local passenger earnings can be increased by $540,000, or $3 per head of population along the line. The increase in through passenger train earnings is estimated at 20 per cent. of the present earnings. The future loss in local passenger traffic by improved service on the competing electric road, if steam locomotive operation is maintained on the Lake Shore, is estimated at $123,000.

The total difference in future passenger-train earnings between electric and steam locomotive operation, therefore, is 20 per cent., of $3,333,000, or	$667,000
Increase in local passenger earnings	540,000
Loss in local passenger earnings avoided	123,000
	$1,330,000

Recently, it has been the policy of steam railroad companies to buy competing parallel electric roads. By such purchase and consequent removal of competition for local traffic, passenger fares can be maintained, which give a larger profit from the local passenger traffic of the two lines than would be obtainable by them when competing with each other and each lowering the fares for the purpose of securing a larger proportion of the total traffic. This increase in profit can be divided among the two companies, and the change of ownership can thereby be made profitable to both.

If the steam railroad is electrified before the purchase of the competing electric line the prospective earnings of the latter are much reduced. This will correspondingly reduce the purchase price. The prospective loss of earnings due to the inferiority of steam railroad operation can only be avoided by the introduction of electric operation, because when the steam railroad purchases the competing electric road, the price includes the capitalized value of this loss of earnings. The avoidance of this loss, therefore, is one of the gains secured by the electrifying of the steam road even if the latter afterward buys the competing electric road.

PRESENT AND FUTURE TRAINS.

At present there are, approximately, 224 passenger train cars going over the line daily. These could not be materially reduced in number, in spite of decreased local traffic. Of these cars, 208 are in through trains. With 20 per cent. increase in through passenger train earnings, 250 cars would be required for the through trains. For the $540,000 increase in local passenger earnings, with earnings of 24 cents per car-mile, 34 cars per day going over the line would be required. This gives 50 cars per day for local traffic, or a total of 300 cars per day for the whole passenger train traffic.

The future traffic can be provided for by an average of 22 daily trains of nine cars and an average of 21 daily trains of five cars, giving a total of 303 cars going daily over the whole line. In reality, the number of trains and of cars per train would vary with the season and, on different parts of the line, with the density of population along the line. As the increase in passenger traffic will be greatly affected by the schedule speeds and as high speeds can be secured at moderate cost by electric operation with cheap water power, it will be advantageous to increase greatly the average train speed. An average increase of one-third over present speeds has been assumed in the following calculations. The through trains of nine cars, therefore, should have a schedule speed of from 50 to 60 miles per hour, according to the number of stops. The five-car trains should have a speed of from 30 to 45 miles per hour with stops from two to six miles apart.

CAPACITY AND COST OF ELECTRIC MOTIVE POWER.

The nine-car train would weigh, with locomotives, 500 tons. The five-car train, with two motor cars, would weigh 250 tons. Two 1,100 h.p. electric locomotives would be required for the long trains, and three 500 h.p. motor cars for the short ones. The horse-power here given is not the commercial rating, but the average capacity of the motors in service.

The present freight traffic is estimated at 34 revenue and three work trains per day going over the whole line. It is assumed that the amount of freight traffic will not be affected by the method of operation. The average weight of freight trains is estimated at 1,600 tons. The trains going east are much heavier than those going west. Two 1,100 h.p. locomotives would be needed for the heaviest trains. Two such locomotives can haul a train of 2,200 tons at 36 miles an hour over a level, straight track. If an average of two locomotives is used per train much higher speeds can be maintained than with the present steam locomotives. Assuming

*From a paper presented Nov. 21, before the American Society of Civil Engineers. Published in the Proceedings of the Society for September, 1906, page 643.

35,000 revenue train-miles per year per electric passenger locomotive, two-thirds of this number per electric motor car, and 25,000 per electric freight locomotive, which allows for the fact that each train is assumed to have two or three motor units, there will be required, for the above traffic, 42 passenger locomotives, 90 freight locomotives and 60 motor cars.

From various data, the following estimate of the cost of this motive power equipment is obtained:

42 passenger locomotives, each 1,100 h. p., at $33,000	$1,386,000
90 freight locomotives, each 1,000 h. p., at $30,000	2,700,000
60 motor cars, each of 500 h. p., at $18,000	1,080,000
Total	$5,166,000

PASSENGER CARS AND LOCOMOTIVES SAVED.

The present passenger traffic requires 14,960,000 car-miles, or, with 45,000 car-miles per car, 332 cars. The future traffic will give 70,000 car-miles per car. It will require 76,032,000 car-miles per year, not counting the motor cars, of which there are three in each five-car train. There will be needed 229 passenger cars, and 103 passenger cars will be saved. From data in the published report of the Lake Shore Railroad it is inferred that 150 locomotives will be saved. The value of the rolling stock saved is estimated at $2,286,000; the net cost of new rolling stock, therefore, is $5,166,000, less $2,286,000, or $2,880,000.

NEW TRACK AND STRUCTURES REQUIRED.

The length of track at present on the 183 miles of line between Buffalo and Cleveland is estimated at 550 miles. The larger passenger traffic will require additional track. The necessary new track is estimated at 50 miles, its cost at $1,000,000. For this traffic there would be required seven transformer stations having a total capacity of 45,000 k.w., costing, complete, $8 per k.w., or $360,000. For each track is needed a 1¼-in. suspended contact rod with suspenders 12 ft. apart; for each rod, one 1-in. carrying rope of 40 tons ultimate strength, with 7 ft. maximum vertical sag and 350-ft. spans. For every 350 ft. of line one overhead bridge will span the tracks and be supported between two steel transmission towers. The towers are required to carry the high-tension lines and feeders. To reduce to 4 per cent. the average loss in the secondary circuit, with maximum traffic and with 15,000-volt, 25-cycle, single-phase current, two No. 0, B. & S. gage, copper feeders are required for each pair of tracks. The contact rods should be in insulated sections two miles long, the ends and center of the sections connected to the feeders by circuit breakers, so that any section of the rods can be cut out in case of a short-circuit. The rails must be bonded and cross-connected to serve as a return circuit. On account of the low conductivity of the rods for alternate currents, the transformer stations must be nearer together than if 0000, B. & S. gage, contact wires are used with the same relay feeders. The contact rods carry for most of the distance but a small current, and the rail return circuit to the transformer stations is shorter than with contact wires. The secondary circuit with contact rods, therefore, has about the same self-induction as the longer secondary circuit with contact wire.

The cost of the secondary circuit, the towers along the line for the primary circuit, and the transformer stations, all per mile of track, will be approximately as follows:

Supporting steel structure, insulators, circuit-breakers, etc.	$2,428
Transformer stations	600
Contact rods and suspenders	712
Ropes	608
No. 0 feeders and accessories	372
Track bonds, etc.	80
Total per mile of track	$4,800

This makes the total cost, for 600 miles of track, $2,880,000. The cost of steel erected is assumed to be 3 cents per pound; that of concrete foundations, $8 per cu. yd. Power would be obtained from Niagara Falls. Two lines of steel towers, each 25 miles long, would be required between Buffalo and Niagara Falls, at $2,000 per mile, and would cost $100,000. The cost of towers along the line is included in the cost of the contact line.

AMOUNT AND COST OF ELECTRIC POWER.

A maximum of 42,150 h.p. will be needed at the primaries of the transformers in the transformer stations along the line. The average distance of transmission to these stations is 117 miles. If the average voltage received is 50,000, and the loss in transmission 15 per cent. of the power leaving the power station, if the power factor is 85 per cent., and if single-phase transmission is used, then the quantity of copper required for the high-tension transmission line is approximately 5,100,000 lbs. This copper costs, in place, with accessories, about 22 cents per lb. This gives for its total cost $1,122,000. An aluminum line would probably be cheaper. The amount of power needed for the trains given above is obtained as follows:

The train resistance for freight trains is estimated at 8 lbs. per ton. This is intended to cover the small amount of power lost by the use of the brakes, which includes the net grade resistance on the nearly level line. The train resistance of through passenger trains is estimated at 18 lbs., that of the local trains at 26 lbs. per ton. This includes the power wasted by the use of brakes. The last estimate is based on running sheets assuming an acceleration of 1.2 ft. per sec. and a retardation by the brakes of 2.4 ft. per sec. Power is used for lighting the trains, for the operation of the brakes, and for switching. These last three items are estimated at 15 per cent. for freight trains, 7½ per cent. for through passenger trains and 5 per cent. for local trains.

If it is kept in mind that 1 h.p.-day is equal to 23,760 foot-tons per day, the following formulas for the horse-power needed by the 37 daily freight trains averaging 1,600 tons, the 22 daily through passenger trains averaging 500 tons, and the 21 daily local passenger trains averaging 250 tons, each running over the 183 miles of line, are self-evident:

$$\frac{5{,}280 \times 183}{23{,}760} \times 37 \times \frac{1{,}600 \times 8}{2{,}000} \times 1.15 = 11{,}073$$

$$\frac{5{,}280 \times 183}{23{,}760} \times 22 \times \frac{500 \times 18}{2{,}000} \times 1.075 = 4{,}328$$

$$\frac{5{,}280 \times 183}{23{,}760} \times 21 \times \frac{250 \times 26}{2{,}000} \times 1.05 = 2{,}914$$

$$18{,}315$$

The tracks will be so crowded that the freight trains must run mainly during times of small passenger traffic. A load factor of two-thirds, therefore, can be easily secured. The maximum power required at the wheels of the motor units, therefore, will be $\frac{3}{2} \times 18{,}315 = 27{,}473$ h.p. The average efficiency of the electric locomotives and motor cars will be at least 70 per cent.; that of the low-tension transmission, at 15,000 volts, 96 per cent.; that of the step-down transformers, 97 per cent. This gives an efficiency, from the primary of the step-down transformers to the wheels of the motor units, of $0.70 \times 0.96 \times 0.97 = 0.6518$ per cent. The maximum power required at the primary of the step-down transformers, therefore, is $\frac{27{,}473}{0.6518} = 42{,}150$ h.p.

The efficiency of the high-tension transmission is 85 per cent., when the maximum power is transmitted. The total efficiency from the step-up transformer station to the wheels of the motor units, therefore, is $0.6518 \times 0.85 = 55.4$ per cent.

The maximum amount of power required at the secondary of the step-up transformers, therefore, is 49,600 h.p., or approximately 50,000 h.p. At $12 per h.p. this will cost $600,000 a year.

MAINTENANCE AND DEPRECIATION OF ELECTRIC EQUIPMENT.

The cost of maintenance and depreciation of electric locomotives is not known. It is estimated at 10 cents per train-mile, or $3,500 per passenger locomotive and $2,500 per freight locomotive per year. This is probably excessive. The cost of maintenance and depreciation of motor cars is estimated at 8 cents per train-mile, or $1,867 per motor car per year. The cost of maintenance and depreciation of passenger cars is estimated at 1.4 cents per car-mile. With steam locomotive operation, approximately 224 cars go over the whole line daily. The future traffic will require 303 passenger train cars to run daily over the whole line. Of these, 63 will be motor cars and 240 other passenger train cars, an increase of 16. This represents 1,068,800 car-miles per year. The increase in cost of maintenance of passenger train cars, exclusive of motor cars, therefore, is $15,000 per year.

OPERATING COSTS.

The cost of train service and motive power is estimated, first, for the traffic with steam locomotive operation as follows:

Cost of Steam Locomotive Power.—The Lake Shore report for 1905 gives the cost of locomotive power per locomotive-mile for the whole system as 32.07 cents. The revenue train mileage is 15,901,016. The locomotive mileage is 25,741,488.

The cost of locomotive power per revenue train-mile, therefore, is $\frac{25{,}741{,}488}{15{,}901{,}016} \times 32.07 = 55.28$ cents, say, 55 cents. The 28 passenger trains and 34 revenue freight trains per day represent 4,140,000 train-miles per year. The total yearly cost of locomotive power on the line and for the traffic here considered, therefore, is $2,277,000. The trains are larger on this line than the average train of the system; for this reason this is probably an underestimate.

Cost of Electric Locomotive and Motor Car Service.—For electric operations the cost of motormen for passenger trains is estimated at 3 cents, and for freight trains at 6 cents, per train-mile.

Cost of Train Service.—The other trainmen on the freight trains will cost considerably less with electric than with steam locomotive operation, owing to the higher train speeds practicable with the former. The new passenger trains will have about one-third more cars running daily over the whole line and one-third greater speed; the cost of car service, therefore, will remain about the same.

Cost of Maintenance of Way.—In the opinion of high authorities, the cost of maintenance of way is mainly caused by the steam locomotives. The excessive weights on the drivers of the largest locomotives, especially at high speeds, are very severe on the track. The imperfectly balanced drivers and the heavy reciprocating parts produce vertical hammering and lateral swaying. The electric locomotives have no heavy reciprocating parts, and the weights on the drivers are very moderate. The cost of maintenance of way will

probably be largely reduced. The amount of this reduction is unknown and is here neglected.

Summary of Comparison of Costs.—The results of these considerations are summarized in the following tabulation:

Estimated future daily trains on 183 miles of line from Buffalo to Cleveland with steam locomotive operation:

28 passenger trains of 8 cars,
34 revenue freight trains,
3 work trains.

Est. future passenger earnings with steam-locomotive operation	$3,467,000
Est. increase of passenger earnings by electric operation	1,330,000
Future passenger earnings with electric operation	$4,797,000

Future trains with electric operation:

34 revenue freight trains,
3 work trains,
22 passenger trains of 9 cars,
21 passenger trains of 5 cars.

Cost on New Plant for Electric Operation.

50 miles of tower lines	$100,000
5,100,000 lbs. copper for high-tension lines, in place, with switches, lightning protection, etc.	1,122,000
Overhead contact lines, sub-stations, and track bonding, etc., for 600 miles of track	2,880,000
50 miles of new track	1,000,000
	$5,102,000
42 passenger locomotives of 1,100 h. p. at $33,000	$1,386,000
90 freight locomotives of 1,000 h. p. at $30,000	2,700,000
60 motor cars of 500 h. p. at $18,000	1,080,000
	$5,166,000
150 steam locomotives and 163 passenger cars saved	2,286,000
Net cost of new rolling stock	$2,880,000
Total	$7,982,000
Contingencies	798,000
Total new investment	$8,780,000

Cost of Electric Operation of Future Traffic.

Current, 50,000 h. p., at $12	$600,000
Maintenance and depreciation of 50 miles of tower lines, 3 per cent.	3,000
Of copper, etc., for high-tension lines, 1½ per cent.	16,800
And depreciation, 600 miles contact line and sub-stations, 4%.	115,200
And depreciation of electric locomotives, 10 cts. per train-mile	394,100
And depreciation of motor cars, 8 cts. per train-mile	112,224
Motormen of freight trains, 6 cts. per train-mile	148,296
Motormen of passenger trains, 3 cts. per train-mile	86,170
Increase in cost of maintenance of passenger cars	15,000
Total	$1,490,790
Interest and taxes on cost of plant, 5 per cent.	439,000
	$1,929,790
Cost of steam-locomotive power saved	2,277,000
Net saving	$347,210
Increase in passenger earnings	1,330,000
Total gain	$1,677,210

This is 19.1 per cent. of the capital invested, and is in addition to about 4 per cent. interest counted among the yearly expenses. If the power were derived from four steam turbine power stations along the line, the stations with their machinery would cost about $3,200,000. The transformer sub-stations could be replaced by feeders. The power could be produced at the stations in the form of 15,000 or 20,000-volt, single-phase current. The saving in the cost of the transmission system would be about $1,200,000. The net increase in investment would be about $2,000,000.

The efficiency of transmission would be about 95 per cent., and the total efficiency, from power stations to wheels, $0.70 \times 0.95 = 66.5$ per cent. The average power required at the power houses would be approximately 20,600 k.w., its cost at the power house would be approximately $60 per k.w. per year, or $1,236,000, allowing 5 per cent. on the cost of the plant for interest and taxes. The cost of water power and of its transmission, amounting, with interest and taxes on transmission plant, to $680,900, would be saved. The net increase in yearly cost of operation and interest and taxes, therefore, would be $555,100. This would reduce the yearly gain from electric operation to $1,142,200, or 10.6 per cent. on the investment. Adding 4 per cent., as previously allowed, the total return on the invested capital would be 14.6 per cent. With the more expensive steam power, better financial results would probably be obtained with slower passenger trains, requiring much less power. It is apparent, therefore, that the electric operation of lines of similar amount and kind of traffic will be profitable even where no water power is available. The density of population along the line, the degree of its prosperity, the presence or absence of a competing electric line, and the fare per passenger mile determine the increase in local passenger traffic that can be counted upon. The amount of existing through passenger traffic on the line considered, and the intensity of competition for it, as well as the amount of the through passenger traffic on the competing lines and the fare per passenger mile, determine the increase in through passenger traffic which will be the result of electric operation and the consequent improvement in the service. On all lines of large traffic, the increase in traffic capacity of a given number of tracks will give valuable advantages which have been entirely neglected in this calculation.

ALTERNATE ESTIMATE.

The adopted estimates of the increase of the passenger earnings are based on voluminous statistics of the amounts of passenger earnings secured by interurban electric roads. These statistics can be found in various technical and financial periodicals of the last few years. The writer was greatly surprised at the amount of new passenger traffic developed by these roads. Without knowledge of the results obtained by them, he would have considered excessive the estimates here given for the probable increase of earnings due to the introduction of electric operation. It would probably require a longer paper than that here submitted to convince those unfamiliar with the facts here referred to that the estimate herein adopted is conservative and will be more than confirmed by the actual results. Since this estimate will be accepted as reasonable by but few without the elaborate proofs which cannot here be given, it is desirable to show how a lower estimate of the increase in earnings will affect the rate of return on the invested capital.

Where Niagara Falls or other equally cheap power is obtainable it can be easily shown that the electric operation of a line with the traffic here assumed is advisable even with one-half the increase in passenger earnings above estimated. The reduction of $665,000 in passenger earnings, as compared with the foregoing estimate, would permit a reduction of one in the average number of cars per passenger train. The locomotives for the through passenger trains would then have to be of 1,000 h.p., and the local passenger trains would require, with a slight reduction of the schedule speeds, an average of two motor cars instead of three. This would reduce the power required to 94 per cent. of the former amount. An equal reduction would take place in the required capacity of the transformers, and in the amount of copper in the high-tension lines.

The number of motor cars required would be reduced to 40. The reduction in cost of plant would be approximately as follows:

Copper for high-tension line	$67,300
Transformers	21,600
Motor cars	360,000
Electric locomotives	126,000
20 passenger cars	80,000
	$654,900
Contingencies, 10 per cent.	65,500
Total reduction of cost of plant	$720,400

This gives the revised cost of plant as $8,059,600.

The reduction in yearly cost of operation would be as follows:

Current	$36,000
Maintenance of copper	1,600
Maintenance of sub-stations	1,000
Maintenance and depreciation of motor cars	37,400
Maintenance of passenger cars	20,579
Interest and taxes on cost of plant	36,020
Increase in net saving	$131,990

The new net saving by electric operation would be $479,200. If $665,000 is added, for the new increase of passenger earnings, the result will be $1,144,200 as the total gain by electric operation. This is 14.2 per cent. of the total investment. The total return on invested capital, inclusive of about 4 per cent. interest allowed among the operating expenses, therefore, is 18.2 per cent. This estimate will undoubtedly appear more reasonable to those acquainted with recent results on interurban electric roads.

COST OF HAULING A CAR.

It is of interest to compare the cost of hauling a freight or passenger car one mile by steam locomotive and by electric power. In this calculation it is fair to include the interest and taxes on the cost of the plant, because the stockholders, who will govern the decision, are mainly interested in the question whether the cost of hauling, inclusive of the new interest charges, is increased or decreased.

It is found, by distributing the total cost of locomotive power among the number of revenue train-miles, that the cost per revenue train-mile is approximately 55 cents. If this cost is assumed to be the same for passenger and freight trains, there is obtained, with eight cars per passenger train, 6.875 cents as the cost per car-mile. This does not include the interest and the taxes on the value of the locomotive and tender. Taking their value to be $12,500, and estimating, from published data, the number of revenue passenger train-miles per locomotive at 33,000 a year, and taking interest and taxes at 5 per cent., the interest charge per car-mile is equal to $\frac{12,500 \times 0.05}{33,000 \times 8} = 0.237$ cents. This gives for the total cost of hauling a passenger car one mile in a revenue train by steam locomotive $6.875 + 0.237 = 7.112$ cents. This includes the estimated share of the cost of switching and work trains.

The freight cars at present in use vary considerably in size. The writer has calculated the cost of hauling one mile a car weighing 70 tons when fully loaded, inclusive of the estimated share of the cost of the switching and work trains. For the average train of 1,600 tons the locomotive and tender will weigh approximately 150 tons. The cost of hauling a train one mile is 55 cents, exclusive of interest and taxes. Taking 23,000 revenue freight train-miles per locomotive per year, the interest and taxes per train-mile amount to $\frac{12,500 \times 0.05}{23,000} = 2.72$ cents; this makes the total cost of hauling a freight train one mile, including a proper share of the cost of the switching and work trains, 57.71 cents. The average train of 1,600

tons, inclusive of locomotive, contains 20.71 cars of 70 tons. The cost per car-mile, therefore, is $\frac{57.71}{20.71} = 2.788$ cents.

For determining the cost of electric power at the motor car or electric locomotive there must be added to the cost at the power house that of transmission. The cost of the transmission plant proportioned for receiving 50,000 h.p. and delivering at motor cars 39,575 h.p. is $4,102,000. The total cost of the delivered power, therefore, is as follows:

50,000 h. p. at power station	$600,000
5 per cent. interest and taxes	205,100
Maintenance of copper, etc.	16,800
Maintenance of 50 miles of tower line	3,000
Maintenance of secondary lines and transformer stations	115,200
Total cost at train of 39,575 h. p.	$940,100

Cost per horse-power per year, $23.75.

Since the load factor is two-thirds, the horse-power-year contains two-thirds of 8,760 horse-power-hours. The cost of power per horse power-hour used at motor car or locomotive, therefore, is 0.4067 cents. The power required at the wheels for hauling 22 daily through passenger trains 183 miles was found to be 4,328 h.p. This includes the power required for switching, train lighting and the operation of the brakes. It does not include the power for the three work trains. The latter is $^3/_{37}$ of 11,073 = 898 h.p. In the calculation of the cost of steam power all the costs of power have been charged to the revenue trains. Following the same method, the cost of the power for the work trains will be charged to the cost of hauling the passenger trains. The cost of power per passenger train-mile becomes, therefore $\frac{(4,328 + 898) \times 24}{22 \times 183 \times 0.7} \times 0.4067 = 18.11$ cents. These trains have an average of nine cars; the cost of power per car-mile, therefore, is 2.012 cents. The costs incurred on the locomotive, per revenue train-mile, are 10 cents for maintenance and depreciation, 3 cents for motormen, 4.73 cents for interest and taxes, a total of 17.73 cents, or 1.97 cents per car-mile. This gives the total cost of hauling a passenger car one mile 2.012 + 197 = 3.982 cents. The schedule speed of this car is one-third greater than that of the car hauled by the steam locomotive. This higher speed increases the energy required about 25 per cent. The corresponding cost of steam locomotive haulage at the slower speed was found to be 7.112 cents. Steam locomotive haulage at the higher speed, if practicable at all, would cost more than twice as much as electric haulage.

It was found that it takes 11,073 — 898 = 10,175 h.p. to haul 34 daily revenue freight trains a distance of 183 miles. The cost of power per revenue train-mile, therefore is $\frac{10,175 \times 24}{34 \times 183 \times 0.7} \times 0.4067 = 22.81$ cents.

The costs per train-mile on the locomotive are: Maintenance and depreciation, 10 cents; motormen, 6 cents; interest and taxes, 6 cents; total, 22 cents. The cost of hauling a 1,600-ton freight train one mile, therefore, is 22.81 + 22 = 44.81 cents. This is $\frac{44.81}{20.71} = 2.164$ cents per car-mile. This includes the cost of switching and the operation of the brakes. The speed is one-third greater than with steam locomotives; this reduces the cost of the train crews per train-mile. The corresponding cost of steam haulage at the slower speed is 2.788 cents. In the same manner the cost of hauling with electric power a passenger car of a five-car train is found to be 5.09 cents. The schedule speed is one-third greater than for steam trains with the same number of stops. All items of cost that are the same with steam locomotives and by electric operation have been omitted in these comparative estimates.

CONCLUSIONS.

Unless these calculations are greatly in error, it is evident that electric operation of many steam railroad lines will be extremely profitable, especially where the passenger traffic is large, where there are no existing parallel electric lines, and where cheap water powers are available.

All estimates of cost of electric plant and operation were intentionally taken very high. The writer is convinced that the cost of electric operation here given is in excess of what it will prove to be upon actual trial. The figures given were chosen with a view of being able to prove from past experience with similar, though not identical, apparatus and plant that they are at least adequate. The cost of single-phase electric locomotives and motor cars will probably greatly decrease within a short time, and this will make possible a much better showing for electric operation. For roads with small traffic, an entirely different and much cheaper contact line, and smaller and slower trains would be used. The results here obtained do not justify any inference either for or against the electric operation of such roads.

Various estimates of the cost of electrically operating a given amount of either freight or passenger traffic have been published. The writer believes that the only way to obtain a correct answer to the question, Will electric operation pay? is to consider the problem as a whole, and to compare the probable increase in future net earnings, due to the changes and improvements in passenger service which become practicable and will be adopted with the introduction of electric operation, with the required new investment of capital. Wherever electric operation has been adopted, the gain in passenger earnings has been by far the most important factor in making the change profitable.

Steel Rails.*

BY ROBERT JOB.

Twenty or thirty years ago steel rails did not cause the difficulty which is found with the present product. This is due to a number of causes. A vastly greater tonnage is handled to-day by the mills, and the same care is not used in the preparation and cropping of the ingots, while in the rolling much higher finishing temperatures are maintained, resulting in coarser structure with relatively rapid wear. In many cases the composition is better to-day than formerly, yet in spite of what, under present practice, would be considered dangerous composition, it is a well-known fact that the old rails gave generally excellent service, this being due largely to thorough working of the steel down to a low finishing temperature. Some old 67 John Brown rails rolled and laid in 1864 have been in track for 34 years. The composition was as follows: Carbon, .330 per cent.; phosphorus, .039 per cent.; manganese, .390 per cent.; sulphur, .030 per cent.; silicon, .070 per cent.

An 80-lb. rail of somewhat the same general composition, namely: Carbon, .396 per cent.; phosphorus, .072 per cent.; manganese, .660 per cent.; sulphur, .033 per cent.; silicon, .286 per cent; and rolled a few years ago has a far greater coarseness of structure. Under the same traffic the one has given long service, while the other would cut out rapidly.

Rails with coarse structure obtained at present and with a composition of carbon, .620 per cent.; phosphorus, .094 per cent.; manganese, 1.000 per cent.; sulphur, .033 per cent.; silicon, .100 per cent. wear relatively rapidly and tend to brittleness when the steel is unsound.

The question arises, why is not the former close-grained slow wearing structure produced to-day? Is the change due merely to the insistent efforts of the mills for higher tonnage, or do other elements enter into the case? The answer is complex. In the first place the increased weight of the present sections of 90 or 100 lbs. per yard instead of 60 or 65 lbs. has radically upset the ratio between the various components of the area of the rail, that is, head, web and flange. The former is far thicker and of much greater mass than formerly, while the other parts in many cases have increased but little in thickness, or even have decreased. As a result of these changes the flange gets to the lowest temperature at which it can be rolled long before the head reaches the same temperature, so that even though the flange be fine grained and tough, as fine even as was obtained in the old practice, the crystals of steel in the head may be very coarse, since they were growing in size from the time that pressure upon them in the rolls ceased until the steel at that point had fallen below a dull red heat. This condition would mean relative rapid wear and brittleness.

It is evident that in order to get fine grained structure clear to center of head two courses are open. First, to rearrange the proportions of the rail in such manner that each component part shall reach the critical temperature at more nearly the same time, as in the old sections, or, secondly, to change the heat treatment given the steel, either during the rolling or subsequently. By the first method the large crystals would be prevented from forming, while by the second, even though formed, they would be broken up by the reheating.

In some of the mills it is common practice to hold the rail before the last pass with the object of giving greater toughness and better wearing qualities to the steel, owing to the finishing at a lower temperature. Unluckily the plan is of little benefit, since thereby a fairly fine granular structure is produced to a depth of only about an eighth of an inch from the surface. This, in service, is quickly worn away, exposing the coarse structure beneath. What is needed is thorough working of the steel throughout its mass at a temperature as near as possible to its critical point.

As an example of the influence of heat treatment after rolling, it may be of interest to detail the results of an investigation carried out several years ago under our direction upon the Reading Railway. Eleven 90-lb. rails of coarse granular structure were, through the kindness of the Pennsylvania Steel Company, sawed in halves, and one-half of each run into a reheating furnace, brought to a cherry red, and at once removed and let cool in the air. The annealed rails assumed a structure in which the coarse granular condition was entirely obliterated and replaced by a very fine structure resulting in great toughness. These 22 rails were laid in track at Reading at a point where they were subject to slow heavy traffic. All of them were in the same line, laid alternately, first an annealed

* Abstract of a paper read before the New York Railroad Club, Nov. 16, 1906.

rail, and then its untreated half. From time to time measurements were made of the contour with a rail indicator. After being subject to a traffic of approximately 88,128,000 tons, we were surprised to find that the annealed rails showed 31.9 per cent. the more rapid wear, while they also showed the greatest tendency to mash down and splinter. The average loss of weight was 2.85 lbs. per yard for the untreated rails and 3.77 per yard for those treated. Upon cutting out strips from the heads and subjecting to tensile test we found the following averages:

	Natural.	Annealed.
Tensile strength, lbs. per sq. in.....	129,700	126,100
Elastic limit, lbs. per sq. in.....	80,600	70,225
Elongation, 2-in. section, per cent.....	21	22

The composition averaged about as follows: Carbon, 0.540 per cent.; phosphorus, .079 per cent.; manganese, 1.060 per cent.; sulphur, .080 per cent.; silicon, .090 per cent.

This trial showed that heavy traffic high elastic limit is essential to the best service, and it was also evident that if we propose to get greater toughness and safety by some treatment, like the annealing, which lowers the elastic limit, we should also, to get the best results, increase the carbon or manganese content to the point at which the elastic limit will be high enough to resist crushing, even though the steel be somewhat unsound. In other words, the toughness and elasticity produced by the fine granular structure permit an increase in the hardening contents considerably beyond the point which otherwise would be safe, thus obtaining greater capacity for wear.

Unfortunately, annealed rails, with their freedom from brittleness and internal strain, are of hardly more than theoretical interest, since they cannot be obtained in any considerable quantities under present conditions.

We have already referred to the influence which the type of section may exert upon the granular form of the steel, and hence upon the strength and ductility of the product. It has been our experience also that the form of section may yield a decided influence upon the mechanical strength of the rail. To express the matter in another way, we may say that with steel of precisely the same composition and degree of porosity one section will tend to support loads better and show greater freedom from crushing and splintering than will another section of the same weight per yard. To illustrate the point we may cite an instance which occurred upon the Reading. A considerable length of track had been laid in 1890 with 90-lb. rails of the then standard P. & R. section, which had a rather deep head with angle at the side of head approximating the converse of a wheel flange. These rails gave excellent service for 14 years, and in order to note the comparative influence of section upon wear, we arranged to have a number of them removed and placed in track, turned, on an 8-deg. curve, in the same track and adjoining 90-lb. rails of the A. S. C. E. section. Measurements were taken last May, after one year's service, and we noted that very little wear had resulted with the P. & R. section rails. The top of head after 15 years' service is but little affected, while the angle at side of head is almost unchanged. The composition of one rail averaged: Carbon, 0.600 per cent.; phosphorus, .070 per cent; manganese, 1.000 per cent.; sulphur, .060 per cent.; silicon, 120 per cent.

Another rail of the same section showed considerably more wear, although the side angle was little changed. In this rail the composition averaged: Carbon, 0.500 per cent.; phosphorus, .085 per cent.; manganese, .900 per cent.; sulphur, .070 per cent.; silicon, 100 per cent.; and the effect of the increased softness of the steel is clearly evident in the greater wear. In the case of the A. S. C. E. section, the side of the head was ground away until the contour approached that of a wheel flange, although little wear was found upon the top of head. The composition averaged: Carbon, 0.570 per cent.; phosphorus, .088 per cent.; manganese, 1.000 per cent.; sulphur, .065 per cent.; silicon, .120 per cent.

From this instance it will be seen that the square head rail holds its angle for only a comparatively short time under heavy traffic, and it is also a matter of frequent observation that when porosity of the steel is present, rails of the square-head type have a much greater tendency to sliver and crush along the outer edge than do rails of the other type or section, the reason evidently being that the mass of metal supporting the edge is very much less in the former than in the latter.

A good deal of discussion has arisen from time to time concerning the effects consequent upon overloading of rails, and in some instances we have heard manufacturers attribute the crushing down and splintering of their product to the heavy wheel loads now prevalent. A lot of 90-lb. A. S. C. P. rails had been furnished upon an absolute guarantee of five years' service, but a considerable number had mashed down completely within six months. The mill made inspection and refused to make replacement, claiming that the condition was simply a result of heavy-wheel loads and other severe conditions for which the mill was not responsible. The appearance of an etched section proved beyond all possible contention that the failure was due to unsound steel, and replacement was made without further quibbling.

The appearance of the fracture of a rail which has failed owing to overloading is distinctive. The fracture generally takes place immediately over a tie, due, of course, to the repeated straining of the metal beyond its elastic limit. At first, merely a hair crack is found. This, with repeated bending, gradually extends into the rail and the broken surfaces become smooth and darkened by oxidation, as shown in the figure. Finally, the remaining metal is too slight to support the weight of a passing load, and the final fracture occurs. We have taken one of these light rails from track, broken it under the drop, and found one of these typical cracks developing over each tie showing clearly the need of close watchfulness in the maintenance of track subjected to heavy traffic.

We have referred above to the necessity of avoiding porosity and unsoundness of steel if good service is to be obtained. Curiously enough a frequent characteristic of nickel steel is somewhat allied to this condition. It is a matter of general observation that nickel steel rails have not given the service which was anticipated and hoped for, but that there has been a tendency to sliver and to have a life not at all proportioned to the cost. Several years ago, while investigating some of these rails, we came upon a condition which seemed to account fully for this unfortunate behavior. The very lightly etched surface of an 80-lb. nickel steel rail of the following composition: Carbon, .530 per cent.; phosphorus, .093 per cent.; manganese, .940 per cent.; sulphur, .040 per cent.; silicon, .082 per cent.; nickel, 3.480 per cent.; showed a number of dark spots scattered over the section. These we found were not particles of slag or oxide due to failure to crop the ingots to clear metal, for the steel was thoroughly sound. The spots had a silvery appearance and were exceedingly hard, and evidently were either pure nickel or else an alloy high in nickel. The important point was that the metal was not homogeneous, and at these places appeared to be imperfectly welded, so that under severe stress the effect would be the same in a way as though the line of hard alloy had been a line of slag. There would be an imperfect bond and the surfaces would slip apart and slivering would result. Upon taking a portion of this at center of head etching and magnifying fifty diameters, we found that the greater part of the area was of exceedingly fine uniform structure. There were, however, occasional patches of metal in which relatively large silvery granules appeared, showing that the nickel had evidently not thoroughly melted and diffused through the heat. Consequently the strength of the metal under lateral stress was deficient, owing to the seam lines, although if subjected to direct longitudinal force as in the ordinary tensile test it undoubtedly would have been normal and high. Small seam lines extending longitudinally through a rail, are often the cause slivering or "flowing" of the metal. The latter term we found to be usually a misnomer, since the condition to which it is generally applied is in most cases produced by the breaking away of the steel at seam lines under pressure and not by actual elongation of the metal; it is merely a consequence of unsound steel. True flowing of metal takes place seldom, if ever, to a noticeable extent in a thoroughly sound rail, even when of very soft steel. Rapid cutting results in such a rail but little real flowing.

The old John Brown rail, referred to above, although of mild steel and in track for 34 years, has shown no indication of flowing, though it was cut down considerably upon the head. It was, however, of quite sound steel throughout the head, although a slight pipe line appeared in the web.

The important question remains, how can better rails than are now secured be obtained. We have already suggested that by modifying the section of the rail a finer granular form, with its inherent toughness and tenacity, may be obtained. By insisting upon cropping of ingots clear to sound metal, and by testing a rail-butt, which is with certainty known to have been taken from the top of an ingot, so that if marked unsoundness be present the heat may be rejected by the drop test, a reasonable degree of soundness can be secured, and slivering and crushing largely prevented. By increasing the hardness of the rail as much as is compatible with the character of the roadbed, the rate of wear may be decreased, but we believe that further aids are necessary, and can before long be obtained. The Bessemer rail has filled an important need, particularly in the days of light, easily rolled sections and light wheel loads. Under present conditions, however, there is urgent demand for harder, tougher steel. In the Bessemer rail the hardness, with the proportion of phosphorus usually present, cannot be increased much beyond present practice, say, 0.60 or 0.65 per cent. carbon, without causing undue brittleness, and hence advantage has been taken of the basic open hearth process by which phosphorus and sulphur can be nearly eliminated. With these elements of brittleness largely removed the proportion of carbon has been increased safely and with very favorable results to nearly 0.90 per cent., thus securing great hardness, together with great tenacity and a very low rate of wear. Bessemer rails will undoubtedly continue to be used for the lighter sections and in locations where traffic is light, but we believe that under the more exacting conditions this quality will before long disappear, replaced by the harder, tougher steel of the basic open hearth process.

GENERAL NEWS SECTION

NOTES.

The National Express Company has increased the wages of its employees 10 per cent.

The Boston Elevated Railway has increased the wages of its employees, beginning January 1, an average of 10 cents a day.

The Cumberland Valley Railroad has increased the pay of its employees 10 per cent., the change to take effect December 1st.

The National Tube Works Company, of Pittsburg, has received an order for 430 miles of 8-in. iron pipe to be used for an oil pipe line to connect the oil fields of Indian Territory with Port Arthur, Tex.

It is reported that the Union Pacific will not comply with the ruling of the Interstate Commerce Commission that party rates for theatrical companies must be no lower than similar rates open to all.

Telegraph operators on the main line of the Union Pacific now receive 10 per cent. commission on the commercial (Western Union) telegraph business that they handle, limited to a maximum of $15 per month.

The New York City Railway, operating the street surface cars in Manhattan, announces to its employees that all its cars are to be equipped with vestibules, for the protection of the motormen from cold in the winter.

A press despatch from Boston says that the members of the Boston Transit Commission have been arraigned in court and required to furnish bail in $50 each for the crime of having printing done at a shop where the employees worked more than eight hours a day.

On the night of November 18 two trespassers (who have not been found) took a locomotive out of the engine house of the New York, New Haven & Hartford at Hopewell Junction, N. Y., and ran it, unlighted, 10 miles to Fishkill Landing. They arrived in safety and then left the engine and escaped.

The General Freight Agent of the Seaboard Air Line is distributing a list of cotton mills whose shipping points are on the lines of this road. The list gives the name of the officer to correspond with, the shipping point, postoffice address, class of goods manufactured, number of looms, number of spindles, and kind of power used.

The Great Northern has issued a new freight tariff for most or all of its lines in Minnesota, and extending also into Wisconsin, North and South Dakota and Nebraska. In most of the rates there has been a reduction. From Duluth to Sioux City, the reduction (first class) is three cents, making these rates that much lower than the rates from Chicago to Sioux City.

On Saturday and Sunday last an extensive rain storm did much damage in Tennessee, Mississippi and Arkansas. In the region of Jackson, Tenn., the Nashville, Chattanooga & St. Louis, the Mobile & Ohio, the Southern, and the Illinois Central were unable to run trains for two days. Tracks were washed out for long stretches, bridges are down, and in some places the water stood over the tracks for miles.

The New York State Railroad Commission, reporting on an investigation of street railroad conditions in Brooklyn, recommends the construction of an elevated road in Manhattan to connect the Williamsburg and the Brooklyn bridges (to facilitate street car traffic between Brooklyn and New York), and also recommends the construction of a third main track throughout the length of the Second Avenue and Third Avenue elevated railroads in Manhattan.

During the month of October, 1,393,423 bushels of wheat and 678,903 bushels of corn were shipped from New Orleans. These figures compare with 184,000 bushels and 162,857 bushels, respectively, shipped during the same period of 1905. During the two months ended October 31 there were shipped 2,597,423 bushels of wheat, an increase of 2,301,423 bushels; 713,188 bushels of corn, an increase of 497,008 bushels, and 30,000 bushels of oats, a decrease of 120,224 bushels.

W. J. Lynch, Passenger Traffic Manager of the western lines of the New York Central, in answering the irresponsible assertion that the railroad companies could afford to reduce fares because of the reduction which has been made in the number of passes issued, says that 90 per cent. of the free passes represent travel that would not exist without the passes. Mr. Lynch says that the density of passenger traffic is much heavier in Indiana than in Ohio. He says that the prevailing passenger rate in Illinois is 3 cents a mile; in Indiana, 2½ cents; in Ohio, 2 cents, and in Michigan, 2 cents, 2½ cents and 3 cents.

Chicago newspapers report that the railroads of the northwest and southwest which have been giving passes freely to immigration promoters will withdraw this privilege at the end of this year, and that it will affect thousands of men. The railroads will give regular employment to a few of the most successful of these men. It is also reported from Chicago that the cutting off of passes which has been made or soon will be made on account of the revision of the Interstate Commerce law, will be applied in the same way by the western roads to intrastate traffic; in other words, the whole business of free transportation will be regulated according to the terms of the federal law.

The Interstate Commerce Commission has declined to require railroads to report all cases of false classification of freight. This decision was made on an application of a soap maker of Buffalo, N. Y., who desires to ship premiums in boxes with the soap. The application to the Commission was made in the hope that, if honest classification could thereby be assured, the soap maker could then induce the railroads to carry soap and premiums in the same box at two different rates. It was proposed that "if the actual weight of the articles of each class is shown on the bill of lading, each article shall be charged at its weight and class rate, adding the weight of the box to the weight of the heaviest article."

In the United States Circuit Court at New York City, November 15, the New York Central was found guilty of paying rebates on shipments of sugar from New York to Cleveland, said to have aggregated $26,000. The agreement to pay the rebate—reducing the tariff rate of 21 cents to 15 cents—was made in July, 1902, but the actual payment of the money by the railroad did not take place until after the passage of the amendment to the rate law in February, 1903. As the indictments in this case were based partly or wholly on the provisions of the 1903 law, the railroad company, in its defense, claimed that the charge against it was not proved, as the essential thing—the agreement to pay the rebate—took place before such doings had been declared unlawful.

In the same Court, November 20, the American Sugar Refining Company was found guilty of receiving the $26,000 in rebates.

O. H. Taylor, General Passenger Agent of the New England Navigation Co., has been appointed Passenger Traffic Manager, effective Dec. 5, of the steamship lines controlled by C. W. Morse. These lines are: The Eastern Steamship Company, between Boston and Kennebec river points, Boston and Portland, Eastport and Bangor, Me., also St. John, N. B., as well as numerous other lines operated on the coast of Maine; the Metropolitan Steamship Co., the outside all water line between New York and Boston; the Mallory lines between New York and Galveston, Tex., also Mobile, Ala., and other points; the Clyde line with its various routes from New York and Boston to southern ports; and the Peoples' Line and Troy Line on the Hudson river between New York and Albany and Troy, respectively.

Forty-One Steamboat Passengers Drowned.

On November 18 the steamer "Jeanie" of the Alaska Coast Company and the steamer "Dix" of the Alki Point Transportation Company collided in Puget Sound about two miles north of Alki Point. The "Dix," according to the statement of the captain of the other steamer, was struck amidships while trying to cross the bows of the "Jeanie" and sank almost immediately. According to press reports 41 of the 80 people on board the "Dix" were drowned.

I. C. C. Regulations.

The Interstate Commerce Commission has issued circular No. 6 answering questions which have been presented in relation to orders issued within the past two months. In regard to the filing of joint rates, the Commission wants concise statements of contracts, but does not wish to have division sheets filed. The free transportation of caretakers of freight is interpreted to mean, not only men in charge of animals and fruit, but of perishable vegetables, when caretakers are necessary; and the transportation of these men includes their return to points from which they actually accompanied the freight. The road may carry such persons either free or at reduced rates, but must publish the terms in the freight tariffs. The Commission some time since gave authority to reduce, without notice, any through freight which is higher than the sum of the locals. If such a through freight (not reduced) is complained of, the Commission will probably decide that it is prima facie unreasonable, thus putting the burden of proof upon the carrier to defend the rate.

Applications for permission to change tariffs on short notice must be sent in the regular form and must be signed by the President, Vice-President, General Traffic Manager, Assistant General

Traffic Manager, General Freight Agent or General Passenger Agent, and the signer must give his title. The Commission requests that as far as possible such applications be sent by mail, not by telegraph. Railroads are requested to designate not more than two freight men and two passenger men to manage correspondence between the road and the Commission. The Commission cannot undertake to send its circulars and rulings to more than one passenger official and one freight official on each road. Each company is requested to designate persons to receive the circulars, etc., and report their names to the Commission. The Commission will, upon application, mail its official circulars to regularly organized boards of trade and shippers' associations.

Mr. Harriman on the Rate Law.

The following abstract is made of the address given before the Trans-Mississippi Congress at Kansas City, November 20, by E. H. Harriman:

The impression prevails that I control more miles of railroad than any other man. That statement is made frequently. I deny it. It is not true. I do not control one mile of railroad. I do not believe in one man or any one company controlling vast interests of this kind. There are 14,000 or 15,000 persons who co-operate in the control of railroads and other corporations in which I am interested. One man could not do the work and do it right. We have our stockholders and our boards of directors, and they all share in the responsibility of conducting our affairs. I appear as a dictator in published statements, but I am not. Every important step in our business is considered by many minds before any decision is reported.

Last year this congress passed a resolution antagonistic to the general clamor that increased power be given to the Interstate Commerce Commission in the regulation of railroads and other corporations. Your contention was that the Sherman Anti-Trust law and the Elkins amendment gave the Commission sufficient power to correct existing evils. But since your congress passed that resolution the Congress of the United States has passed a measure which is now a law that gives to the Interstate Commerce Commission almost unlimited power. To the commission is given the power to control all of the railroads of this country. It is composed of seven men, and four of these men constitute a quorum which can control all the transportation lines of the country.

I do not want to criticize the Commission. I believe it acted in good faith when it said it needed more power. But as I said last night, the President, in his Harrisburg speech, intimated that still greater power should be conferred on the Commission. Now, before any further action is taken, I should like to see how the power which exists under the present law will be used. Perhaps it may not be necessary for the Commission to act under the new law. I hope not.

If the Commission makes a mistake in the use of its power conditions may ensue from which the business interests of this country will not recover in a decade. The transportation business is the most vital for the development of the country. No community could prosper without transportation facilities. Your success and the success of the interests you represent depend largely upon the transportation lines of the country.

I think the railroad traffic men have learned by this time that they do not make rates, but equalize them. The rates are made by the communities served by the railroads. Common centers must be treated alike.

You should not disturb rates at this distributing center without affecting all other distributing centers. The rates are controlled by commercial necessities.

But, under the new law, the rates controlled from commercial necessity now may be controlled by political opportunity. The politician may promise a reduction in rates for election to office.

The railroads have reached almost the limit of economy in transportation. If the rates are to be lowered the railroads must be able to carry traffic at less cost than now. The great industrial development in this country since 1899 and 1900 has been due to the fact that the owners of railroads have had confidence in the communities and people served. In order to develop all sections of the country the railroads have improved their lines and spent hundreds of millions of dollars bringing their lines nearer perfection. The railroads must continue to improve. The expenditure of money for railroad improvement gives other business interests a chance to expand. If the railroads are too soon subjected to a reduction of income, where is the money coming from to develop the railroads further and to develop your interests?

Evening Technical Courses at Columbia University.

The Board of Extension Teaching of Columbia University, New York, announces a series of nine evening technical courses which will be given at the university this winter, beginning November 26 and lasting 20 weeks. The courses are under the immediate direction of Professor Walter Rautenstrauch, of the Faculty of Applied Science, and are to be given by professors and instructors of the university and other persons especially qualified. The fees are from $7.50 to $15, and most of the courses are for two evenings a week. The courses are as follows:

Engineering Physics (as illustrated in the mechanical plants of modern buildings): (1) An elementary study of physics: (2) A practical study of steam and electrical machinery, heating, ventilating, water system, wiring, elevators, etc., included in the plant of Columbia University. For two classes of students—those wishing an introductory study of physics as preparation to advanced study in electricity, steam, etc., another winter; those desiring practical training for positions as superintendents of buildings, engineers, janitors, etc.

Elementary Mathematics: Those parts of arithmetic, algebra, geometry and trigonometry used in technical work. Practice with engineering handbooks, tables, etc.

Drafting: A beginner's course; fits for positions as draftsmen; reading of drawings, etc.

Strength of Materials: A lecture course for those who design or manufacture machinery, or modern structures. With this course should be taken either the first or second of the two following courses in design.

Machine Design: Advanced drafting, computations, and designing for persons engaged in the design and manufacture of machinery.

Structural Design: Advanced drafting, computations, and designing for those who do structural work.

Electrical Engineering: A course especially for those engaged in electrical work of any sort.

Steam Engineering: A course for those engaged in the management of steam machinery of any sort.

Special Engineering Problems: A study of any special elementary or advanced engineering problems desired by the student; individual instruction will be arranged for such a period of time as the special problem may demand.

A complete catalogue of these courses will be sent on request. Address Evening Technical Courses, Extension Teaching, Columbia University. Personal information may be secured Tuesday and Thursday evenings, between 7.30 and 9 o'clock, from Benjamin R. Andrews, room 111, Teachers College.

The "Anti-Waste Grabber."

A simple and ingenious device to prevent displacement of the packing waste in journal boxes is shown in the accompanying illustration. It is called an "anti-waste grabber" because it effectually stops the grabbing action of the journal which carries the waste around and wedges it in between the lug of the box and the rotating journal. When the waste gets in this position it wipes the journal in front of the bearing free from lubricating oil and a hot box results.

The "anti-waste grabber" is made from copper wire, in the form of a coil and stiffened by having three wires soldered on the inside to each turn of the coil. At one end of the grabber, the

Anti-Waste Grabber.

wire projects from ¼ in. to ½ in. This projection holds firmly in the waste and prevents the grabber being lost in case a journal box should be open.

The use of this device insures care being taken in packing journal boxes. They cannot be jammed full of waste, as it must be placed evenly and room must be left for the grabber. The weight of the grabber itself has the tendency to hold the waste down and if it does raise a trifle, the grabber strikes the lug on the box and bearing first, preventing further movement. When in this position the waste cannot get beyond the grabber.

It is claimed for the device that the waste will remain in the position placed, that the journal will be lubricated evenly, that there will be a saving in oil, waste and bearings and delays to fast trains will be avoided. These grabbers have been in use for two years on passenger trains of the Lackawanna, and have proven entirely satisfactory. They are made by the V. O. Lawrence Co., Philadelphia, Pa.

Working Hours of English Signalmen.

For the month of February last the railroads of Great Britain, complying with an order of the Board of Trade, reported the total number of instances in which eight-hour and ten-hour signalmen were on duty more than their booked hours. The total number of eight-hour signalmen employed in the United Kingdom was 9,164, and the number of eight-hour periods scheduled for these men to work during the month of February was 225,343. The number of cases in which men worked nine hours was 614; ten hours, 328; eleven hours, 161; twelve hours, 1,086; thirteen hours and upward, 37, making a total of 2,226 instances of overwork. The number of ten-hour signalmen employed was 9,721, and the number of booked periods during the month 229,849. The number of instances in which these men worked eleven hours was 4,065; twelve hours, 5,136; thirteen hours, 171; fourteen hours, 84; fifteen hours, 40; sixteen hours and upward, 16; total, 9,512.

Many of the companies sent with their statements explanatory letters, showing that certain cases of overwork had been due to

extraordinary sickness among the men, or to other emergencies, and to inability to get relief men on duty promptly. Many of the men who worked over hours were employed during the extra time not as signalmen but in other kinds of station work or in attending to lamps. Some of the largest items, however, are not accompanied by any explanation. The Great Central, employing 463 eight-hour men, reports 408 cases of these men working 12 hours. The road employs 358 ten-hour signalmen and reports that men were kept on duty for 12 hours 642 times. The Great Western, the Midland and the South Eastern & Chatham report considerable numbers of cases; but the other large roads report very few.

Radical Recommendations by Mr. Comer.

Mr. B. B. Comer, President of the Alabama State Railroad Commission, has been elected Governor of the state, and by way of indicating the policy that he intends to pursue in his new office, he has made a minority report to accompany the annual report of the commission. In his individual report Mr. Comer recommends the passage of laws to require the railroads to build stations wherever the commission deems them necessary; to make the present freight rates on all lines in Alabama the maximum which cannot be raised, and to compel prompt settlement of claims for stock killed, freight damaged and other non-performance of contracts. He would also have laws requiring the railroads to provide adequate equipment to handle all business on their lines and penalize any case where there is special delay; also car service rules providing for reciprocal demurrage. Mr. Comer says that the waterways of the state are boycotted by the rail lines and he would have the rail lines forced to make traffic contracts with water carriers. He would forbid increase of the stock shares of railroads without the approval of the railroad commission, and when capital is to be increased for the purpose of making improvements he would require a certified schedule of such improvements.

He would provide for the railroad commission ample legal talent to combat the railroads in all cases where the commission seeks to regulate them. He proposes to actively regulate the telegraph and telephone service, and, in general, to supervise all public service corporations.

Surprise Checking for Shippers and Consignees.

The New York, New Haven & Hartford has appointed several general agents of the freight department who are to keep in close touch with every industry along the company's lines in their respective districts. They are to visit each at least once every two weeks, and thus promote an intimate relationship [and get cars unloaded?].

New Signals.

The Houston (Tex.) *Chronicle* says that on the Southern Pacific lines in Texas and Louisiana 280 miles will be equipped next year, with automatic block signals, and that this will nearly or quite complete the signaling of the line between New Orleans and San Antonio.

The Delaware & Hudson is preparing to establish the block system on the line from Rutland, Vt., to Whitehall, N. Y., and from Plattsburgh to Rouses Point.

The Boston & Maine has contracted with the Union Switch & Signal Company for the material for automatic block signals on 1,000 miles of track.

A Symmetrical Time-Table.

The increase in speed of New York and Philadelphia expresses recently announced by the Reading and the Central of New Jersey is to go into effect November 25. The hourly express trains between the two cities (90 miles, excluding the Hudson river ferry) will make the run in two hours, including the ferry. These trains start from New York hourly, 7 a. m. to 6 p. m., and from Philadelphia every hour from 7 a. m. to 8 p. m. In addition, there will be five new express trains each way, a total of thirty-six trains, independent of the Baltimore and Washington expresses. These five new trains will be known as "between the hour" trains, and make all stops cut out on the runs of the hourly trains, which will make no stops between Jersey City and Wayne Junction in either direction.

The five new trains will leave New York and Philadelphia simultaneously at 6.30, 8.30 and 11.30 a. m., and 1.30 and 5.30 p. m., their time for the trip to be 2 hours and 25 minutes.

Increases in Pay.

Negotiations between railroad officers and representatives of their employees, concerning advances in pay, have been reported from a dozen different cities during the past week, and all of the prominent roads appear to have questions of this kind under consideration. The question whether certain classes of employees intend to strike if they cannot get what they want, has also been given its usual prominence during the past week, and the reporter who can so word his announcement as to make a strike appear probable continues in high favor with the editor. Among the more prominent items which seem to be truthful are the following: Norfolk & Western, 10 per cent. increase, December 1, to all employees now receiving less than $200 a month. Chicago & Northwestern, an unsolicited advance to 1,100 agents and 500 operators; estimated total increase, $10,000 a month. Chicago & Alton, 13 per cent., November 1, to all switchmen. Union Pacific (and all Harriman lines), 10 per cent. increase for clerks, to apply probably at general offices and at stations, and perhaps to other station employees. The New York Central is said to be considering a similar increase for clerical employees. The Delaware, Lackawanna & Western has reduced the hours of the enginemen of switching engines, at some of its smaller yards, and of pushing engines, from 11 hours a day to 10 hours. The 10-hour day will apply to enginemen on work trains. Passenger enginemen are to receive $3.60 per 100 miles, an increase of 10 cents; and on the newest heavy ten-wheel engines will receive $3.75. This rate applies also to the runners on milk trains. The negotiations with brakemen, firemen and switchmen have as yet reached no conclusion. The Erie road has not yet reached any agreement with its employees, but the negotiations are still going on. The brotherhood firemen on the road have been voting on the question of giving their committees power to use their own judgment as to the question of calling a strike.

National Convention for the Extension of Foreign Commerce.

A committee of the New York Board of Trade and Transportation announces that a national convention for considering and devising means for the enlargement of the foreign trade of the United States and for promoting the demand abroad for the productions of this country's farms, work shops and mines, will be held at the New Willard Hotel, Washington, D. C., beginning January 14, 1907. All national, state and local associations interested are invited to send at least five delegates each, and the governor of each state is invited to appoint 10 delegates. Elihu Root, Secretary of State, is to address the convention.

Some Comparisons.

Somebody on the Atchison, Topeka & Santa Fe has figured out that the company pays out nearly $500 daily for track-walkers and watchmen. Also $1,150 for the water its locomotives use. The expense of maintaining equipment amounts to $30,000 every 24 hours. While the Santa Fe is liberal in its advertising, it cost more money the last fiscal year to keep snow, ice and weeds off the track than it did to pay for newspaper and magazine advertisements, books of travel, time-table folders and pictures.

Marking Progress.

The Virginia State Corporation Commission is hearing the last evidence in the uniform freight rate inquiry which has been going on with brief intermissions since last spring, and which will soon go to the court. * * * It is believed that the commission will decide against the companies. * * * —*Press Despatch from Richmond.*

TRADE CATALOGUES.

Irrigation.—The Denver & Rio Grande is distributing an interesting and instructive pamphlet describing the methods and excellent results of the irrigation being carried out by the United States Reclamation Service in Colorado. A tunnel six miles long is being built in the Uncompahgre valley to connect the Gunnison and Uncompahgre rivers. It is to be finished by the fall of 1908, and is to carry water to 150,000 acres of now arid land.

Motor Hoists.—The Ingersoll-Rand Co. sends a bulletin illustrating and fully describing "Imperial" motor hoists, including illustrated lists of parts. The apparatus, which consists of an enclosed pneumatic motor driving a hoisting drum through worm gears, can be attached to a crane or any part of a structure, and is controlled from the ground. The load can be locked in any position.

Air-Brakes for Electric Cars.—The Westinghouse Traction Brake Co., Pittsburg, Pa., has issued a circular describing schedule SM straight air-brake equipment for electric cars. Three varieties of this schedule are illustrated and described; the general arrangement of operation is the same in each, but the details differ to suit different conditions.

Electric Headlights.—The Rushmore Dynamo Works, Plainfield, N. J., is distributing an illustrated and full description of their electric headlight for locomotives. This headlight is really a powerful searchlight, and its construction, except that electricity is used instead of gas, is similar to the Rushmore lens mirror acetylene searchlight.

Ice Tools.—Two recent catalogues of the Gifford-Wood Co., Hudson, N. Y., and Arlington, Mass., illustrate and describe, with price lists, ice tools and handling machinery.

Thermodynamics.—The September issue of the *Penberthy Engineer and Fireman*, published by the Penberthy Injector Co., Detroit,

Mich., contains an interesting article on the principles of heat. After some general remarks, a theoretical discussion of the nature of wet steam and superheated steam is given.

Trolley Wire Frogs.—Bulletin No. 4,465 of the General Electric Co. is devoted to trolley wire frogs. Formulæ are given for the proper location of these frogs at turn-outs and for finding the angle of divergence suited to the radius of the turn-out. Several varieties of two and three-way frogs are shown.

Pneumatic Hammers.—Bulletin No. 2,011 of the Ingersoll-Rand Co. is devoted to the "Little Jap" hammer drill. It is a small drill designed for rock work in confined places or where drill holes of small diameter only are wanted.

Chicago, Milwaukee & St. Paul.—The passenger department of this company sends a mailing card calling attention to the deer hunting grounds in northern Wisconsin and the upper peninsula of Michigan.

Air-Brakes.—Bulletin No. 1,508 of the Allis-Chalmers Co. describes the Christensen air-brake, patents for which were recently sold to the Allis-Chalmers Co.

Manufacturing and Business.

Carl R. Green, heretofore President of the Dayton Pneumatic Tool Co., Dayton, Ohio, has resigned and has opened an office in Dayton as a Consulting Mechanical Engineer, making a specialty of compressed air appliances.

Charles M. Jacobs, Consulting Engineer for the Pennsylvania North river tunnel into New York City, has been retained by the French government to build a tunnel under the Seine at its mouth between Rouen and Havre.

William S. Love, Manager of the Chicago office of the Wheeler Condensing & Engineering Co., has been appointed General Sales Manager, with office at 42 Broadway, New York City, effective January 1. Grant Beebe succeeds Mr. Love at Chicago.

The new 37 stall roundhouse of the Northern Pacific at Mandan, N. Dak., is to be equipped with an engine-driven fan and a steam heater built by the B. F. Sturtevant Co. The new shops of the Maine Central at Waterville, Me., are also being equipped with Sturtevant heating apparatus.

The Baltimore Railway Specialty Co. recently completed a malleable iron foundry at Corning, N. Y., for the manufacture of castings used for Baltimore center and side ball bearings. This foundry will also supply malleable iron to the T. H. Symington Co., one of whose plants is close to the new foundry.

Robert W. Hunt & Company, Engineers, The Rookery, Chicago, have been appointed Consulting, Designing and Constructing Engineers for the new municipal electric lighting plant for the city of Milwaukee. The site for the plant has been bought, and work will immediately start upon plans and specifications. The estimated cost is $700,000.

Iron and Steel.

During the month of October the Edgar-Thompson blast furnaces at Braddock, Pa., turned out 128,134 tons of iron and two of the company's rail mills at that place turned out 84,595 tons of standard rails.

Supplies of steel continue very scarce and there is a corresponding stiffening in price. Recent orders for rails include 25,000 tons for the Atlantic Coast Line, 18,000 tons for the Gainesville & Gulf, and 5,000 tons additional for the Texas & Pacific. An unusual number of roads are adding to their orders for early delivery in 1907.

Orders for rails have recently been given by the Virginia Air Line for 4,000 tons, Georgia Railway 4,000 tons, San Francisco & Napa 1,800, Deepwater-Tidewater 2,000, Chicago, Lake Shore & Eastern 1,500, and Monongahela Connecting 5,000 tons. Orders are pending for about 150,000 tons for delivery next year. The Missouri Pacific recently increased its contract for bridge material to the Pennsylvania Steel Co. from 2,500 to 3,000 tons, and the Chicago & North-Western has given a contract to the same company for 400 tons of fabricated steel. This company is still in the market for 1,600 tons, and the Chicago, Milwaukee & St. Paul for 200 tons.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad conventions and engineering societies, see advertising page 24.)

Railway Surgeons.

The New York and New England Association of Railway Surgeons held its annual meeting in New York City last week. The President for the ensuing year is Dr. H. T. Dana; Secretary, Dr. George Chaffee, Brooklyn, N. Y.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Chicago & Eastern Illinois.—H. I. Miller, who was recently elected President of this road and of the Evansville & Terre Haute, worked from October, 1880, to 1888 in various positions in transportation, maintenance and construction departments on different roads. He was then appointed Superintendent of the Richmond division of the Pennsylvania lines, and two years later was transferred to the Louisville division. In 1894 he was made Superintendent of the Terre Haute & Indianapolis, now part of the Vandalia. In 1901 he was appointed General Manager of the Vandalia, and in 1903 went to the Chicago, Rock Island & Pacific as General Manager. Two years later he was elected Second Vice-President and General Manager of the Chicago & Eastern Illinois, and Vice-President of the Evansville & Terre Haute, the Evansville & Indianapolis and the Evansville Belt.

H. I. Miller.

Illinois Central.—Joseph F. Titus, who, as announced in our issue of last week, has been appointed Assistant to the President in charge of the Accounting and Treasury departments, was born in New Jersey in 1859, and was educated at the State Model school at Trenton, N. J. He began railroad work in 1873 as a clerk in the Motive Power department of the Pennsylvania. Five years later he went to the Illinois Central, where he has been ever since. He began as a clerk in the Auditing department of this road, and was later made traveling auditor, then acting paymaster, and then Local Treasurer at Chicago, which position he held until his recent promotion. He now has charge of the departments formerly under the authority of J. C. Welling, Vice-President, who died recently.

J. F. Titus.

Isthmian Canal Commission.—Changes have been made among the officers in charge of the Panama Canal work and of the government of the Canal Zone so that T. P. Shonts, Chairman of the Commission, is now in charge of both, Governor Magoon, of the Canal Zone, having recently been transferred to Cuba. Seven departments instead of three have been created, and will be in charge respectively of J. F. Stevens, Chief Engineer; R. R. Rodgers, General Counsel; W. C. Gorgas, Chief Sanitary Officer; D. W. Ross, Chief Purchasing Officer; E. S. Benson, General Auditor; J. Williams, Chief Disbursing Officer, and Jackson Smith, Manager of Labor and Quarters.

New York, New Haven & Hartford.—T. E. Byrnes, Assistant to the President, has been elected Vice-President, succeeding Percy R. Todd, resigned.

Southern.—H. B. Spencer, General Manager, has been appointed Sixth Vice-President in general charge of the Construction and Purchasing departments, with office at Washington, D. C. C.

H. Ackert, Fourth Vice-President, has been appointed also General Manager, succeeding Mr. Spencer.

Operating Officers.

Chicago & North-Western.—S. M. Braden, Superintendent of the Galena division, with office at Chicago, Ill., has been appointed Assistant General Superintendent of the lines west of the Missouri river. W. D. Beck, Superintendent at Baraboo, Wis., succeeds Mr. Braden. P. J. O'Brien, Superintendent at North Fond du Lac, Wis., succeeds Mr. Beck. F. H. Hammill, Superintendent at Sioux City, Iowa, succeeds Mr. O'Brien. S. H. Brown, Superintendent at Eagle Grove, Iowa, succeeds Mr. Hammill. E. E. Smith, trainmaster at Sioux City, succeeds Mr. Brown. C. E. Andrews, Assistant Superintendent at Escanaba, Mich., has been appointed to the new office of Superintendent of the Lake Shore division, with office at Green Bay, Wis.

Chicago Great Western.—L. M. Shipley, trainmaster at Chicago, Ill., has been appointed Superintendent of Terminals at Oelwein, Iowa, succeeding William Matthie, resigned to go to another company.

Cumberland Valley.—See Washington Terminal.

Mississippi Central.—G. K. Smith, who recently resigned as General Manager of the Detroit, Toledo & Ironton, has been appointed General Manager of the Mississippi Central.

Rio Grande Western.—George Geiger, formerly Superintendent of the Texarkana & Fort Smith, has been appointed Superintendent of the Rio Grande Western at Salt Lake City, Utah, succeeding W. E. Miller, transferred.

Southern.—The lines east and south of Harriman Junction, Tenn., Nashville, Chattanooga and Memphis will hereafter be operated in four districts, with a General Superintendent in charge of each. G. R. Loyall, Assistant General Superintendent at Knoxville, Tenn., has been appointed General Superintendent of the Eastern district, with office at Charlotte, N. C. W. N. Foracre, Assistant General Superintendent at Birmingham, Ala., has been appointed General Superintendent of the Western district, with office at Birmingham. E. H. Coapman, Assistant General Superintendent at Danville, Va., has been appointed General Superintendent of the Northern district, with office at Danville. M. M. Richey, formerly Assistant General Superintendent at Birmingham, but more recently Vice-President of the Sloss-Sheffield Steel & Iron Co., has been appointed General Superintendent of the Middle district, with office at Knoxville, Tenn. J. N. Seale, Assistant General Superintendent at Charlotte, has been appointed to the new office of Manager of Transportation, with office at Washington, D. C.

Washington Terminal.—G. W. Martin, hitherto Superintendent of the Cumberland Valley, has been appointed Superintendent of the Washington Terminal, with office at Washington, D. C.

Traffic Officers.

Chicago, Rock Island & Pacific.—C. H. Morrill has been appointed Industrial Agent of this road and of the St. Louis & San Francisco, with office at St. Louis.

Nashville, Chattanooga & St. Louis.—E. M. Smith has been appointed Assistant General Freight Agent, with office at Nashville, Tenn., succeeding Charles Barham, promoted.

St. Louis & San Francisco.—See Chicago, Rock Island & Pacific.

Wisconsin Central.—Frederick Signer has been appointed General Freight Agent, succeeding Burton Johnson, resigned.

Engineering and Rolling Stock Officers.

Atlantic Coast Line.—C. J. Kelloway, hitherto Supervisor of Interlocking on the Delaware, Lackawanna & Western, has been appointed Signal Engineer of the A. C. L., with office at Wilmington, N. C.

Gulf, Colorado & Santa Fe.—P. T. Dunlop, Master Mechanic at Temple, Tex., has been appointed Mechanical Superintendent, with office at Cleburne, Tex., succeeding A. Harrity, resigned.

Lehigh Valley.—A. W. Whiteford, Superintendent of Shops at Omaha, Neb., of the Union Pacific, has been appointed Shop Superintendent of the Lehigh Valley, with office at Sayre, Pa., succeeding E. T. James, resigned.

Union Pacific.—Hamilton Stovel, general foreman at Omaha, Neb., has been appointed Superintendent of Shops at that place, succeeding A. W. Whiteford, resigned to go to another company. See Lehigh Valley.

Purchasing Agents.

Colorado & Southern.—F. W. Mahl, Mechanical Engineer of the Southern Pacific at San Francisco, Cal., has been appointed Mechanical Engineer and General Purchasing Agent of the Colorado & Southern, with office at Denver, Colo. A. L. Cochrane, Purchasing Agent, has been appointed Assistant General Purchasing Agent, with office at Denver.

Southern Pacific.—See Colorado & Southern.

LOCOMOTIVE BUILDING.

The Marquette & Southeastern has ordered two consolidation (2-8-0) type locomotives from the Baldwin Locomotive Works.

The Cuban Central has ordered one ten-wheel (4-6-0) type locomotive from the Hicks Locomotive & Car Works. This locomotive will weigh 45 tons and have 18-in. x 24-in. cylinders.

The Canadian Pacific is building 10 simple superheater consolidation (2-8-0) type locomotives at its Angus shops. These locomotives are exactly like the 20 consolidation locomotives reported in our issue of October 12, except as to heating surface, which is 2,870 sq. ft. for the 10 locomotives.

CAR BUILDING.

The Colorado & Southern is in the market for 1,000 box cars.

The Grand Trunk is reported to be in the market for 500 refrigerator cars.

The New Orleans Great Northern is in the market for 200 box cars of 80,000 lbs. capacity.

The Cuban Central has ordered ten 36-ft. flat cars from the Hicks Locomotive & Car Works.

The Lehigh Valley has ordered 500 additional box cars from the Standard Steel Car Company.

The Gulf & Ship Island has ordered 500 flat cars from the American Car & Foundry Company.

The Roddis Lumber & Veneer Co., Marshfield, Wis., has ordered two 36-ft. flat cars from the Hicks Locomotive & Car Works.

The Texas Company, 8 Bridge street, New York City, has ordered 300 tank cars from the American Car & Foundry Company.

The Missouri Pacific, it is reported, has ordered 1,500 refrigerator cars from the American Car & Foundry Co., and is asking prices on 3,000 box cars.

The Butler Lumber Co., Butler Spur, Wash., has ordered six 41-ft. logging flat cars of 60,000 lbs. capacity from the Hicks Locomotive & Car Works.

The Tri-City Railway & Light Company, Davenport, Iowa, has ordered 10 street cars from J. G. White & Co., and 200 more are to be built as soon as the first 10 are completed. They will measure 31 ft. long and will carry 36 passengers.

The Chicago, Rock Island & Pacific, as reported in our issue of November 16th, has ordered 10 chair cars, 10 passenger coaches, five observation cars and five dining cars from the Pullman Co., and 10 combination smoking and baggage cars, 10 baggage cars, five steel underframe postal cars, five steel underframe baggage and mail cars, and five combination coach and dining cars.

The Pennsylvania is about to ask bids from the American Car & Foundry Co., the Standard Steel Car Co. and the Pressed Steel Car Co. on 100 all-steel non-inflammable passenger cars. The railroad will at once start building an experimental all-steel dining car, and the Pullman Company is designing for the road an all-steel non-inflammable sleeping car, of which type 500 must be ready for service when the new terminal at New York City is opened to traffic.

The Union Pacific has ordered 10 additional steel motor cars to be built at its Omaha shops. These cars will weigh 57,150 lbs. The passenger compartment will measure 41 ft. 10⅝ in. long, and the engine room 12 ft. 8 in. long; the cars will be 9 ft. 8 31/32 in. wide over side sills, and 12 ft. 1 3/16 in. high from top of rail to top of roof. The special equipment includes:

Bolsters	Commonwealth Steel Co.
Brake-beams	Waycott
Couplers	Climax
Curtain fixtures	Union Pacific special
Curtain material	Pantasote
Light	Adams & Westlake acetylene
Paint	Sherwin-Williams
Wheels, driving	Railway Steel Spring Co.
Wheels, trailer	Standard Steel Works

The Mexican Southern has ordered three narrow gage passenger coaches for February, 1907, delivery from the Mexican Car & Foundry Co. These cars will measure 39 ft. 4 in. long and 7 ft. 4 in. wide, inside measurements; 45 ft. 10 in. long and 8 ft. 3½ in. wide,

over all, and 6 ft. 1 in. high from floor to under side plate. The bodies and underframes will be of wood. The special equipment includes:

Bolsters	Trussed oak
Brakes	Westinghouse
Draft rigging	M. C. B.
Dust guards	Wooden
Journal boxes	Cast iron
Light	Dual burner
Paint	Pullman standard
Roofs	Covered with duck
Trucks	Company's standard four-wheel

The Atchison, Topeka & Santa Fe, as reported in our issue of November 9, has ordered five postal cars and 17 additional baggage cars from the American Car & Foundry Co., for December delivery. The postal cars will weigh 105,200 lbs., and will measure 60 ft. long, 9 ft. ½ in. wide and 7 ft. 7½ in. high, inside measurements. The baggage cars will be 69 ft. 2⅛ in. long, 9 ft. 3⅝ in. wide and 6 ft. 8½ in. high, inside measurements. The special equipment for both includes:

Brake-beams	Chicago Railway Equipment Co.
Brake-shoes	American Brake-Shoe & Foundry Co.
Brakes	Westinghouse
Brasses	Hewitt
Couplers	National
Draft rigging	Miner
Dust guards	A., T. & S. F. standard
Journal boxes	Symington
Light	Pintsch
Springs	Simplex Railway Appliance Co.
Vestibules	Pullman standard
Wheels	Standard Steel Works

RAILROAD STRUCTURES.

Armourdale, Kan.—The land which the Chicago, Rock Island & Pacific recently bought at this place is to be used for enlarging the freight yards, but not for new shops. A new roundhouse is to be put up to replace the present one.

Atlanta, Ga.—The Gate City Terminal Company, which is to provide an entrance for the Atlanta, Birmingham & Atlantic into this city, has agreed to build a bridge over Hunter street and underpasses at Western avenue and at Meldrim street, also to widen and pave other streets.

Cedar Falls, Iowa.—The Illinois Central, it is said, will at once being work on a new brick station here.

Des Moines, Iowa.—The Interurban Railway Company will build a combined storage and car repair shop of brick and steel to cost $25,000.

Elkhart, Ind.—The car repair shops of the Lake Shore & Michigan Southern were recently damaged by fire; loss about $40,000.

Evansville, Ind.—The Evansville & Terre Haute is having plans made for putting up a stone passenger station here.

Hamilton, Ont.—The Canadian Pacific is having plans made for a large office building.

A contract has been given at about $225,000 to the Canadian White Co. for the Union Electric Railroad station by the Cataract Power & Traction Company.

Lethbridge, Alberta.—A contract for the steel work on the Canadian Pacific bridge at this place has been given to the Dominion Bridge Co., of Montreal. The contract amounts to about $780,000.

Lincoln, Neb.—Plans are being made by the Union Pacific to increase its terminal facilities. The yards are to be enlarged and a new passenger station also a new freight house put up.

Mackinaw, Ill.—The McKinley Company has given a contract to Burham & Ives, of Bloomington, to build a bridge over the Mackinaw river, for the use of the Interurban lines.

Mount Carmel, Ill.—The Cleveland, Cincinnati, Chicago & St. Louis has plans made for putting up a two-story passenger station 36 ft. x 112 ft., to cost about $23,000.

Nebraska City, Neb.—The Chicago, Burlington & Quincy will put up a new brick passenger station here to cost $40,000.

New York, N. Y.—Plans are being made by Walker & Morris for the superstructure of the Whitehall street ferry terminals which have recently been taken over by the city. Commissioner Bensel, of the Department of Docks and Ferries, will soon ask bids for the work, which will cost approximately $500,000.

Omaha, Neb.—An officer writes that the Chicago & North-Western has just started work on a brick steel skeleton two-story freight house to be 86 ft. x 718 ft.

Richmond, Va.—The Chesapeake & Ohio has given contracts to A. M. Walkup to build floors over the basin from Eighth street to Twelfth street 160 ft. wide, which will give that company an additional three acres of floor space to be used for freight facilities. The cost of the improvement is about $200,000.

Saskatoon, Sask.—A contract has been given to John Guinn & Son, of Winnipeg, at $90,000 for putting up the Grand Trunk Pacific bridge here.

South Bend, Ind.—The Northern Indiana Railway Co., it is reported, is making plans for putting up a large power station here.

Syracuse, N. Y.—A contract has been given by the C. D. Beebe Syndicate of Electric Railroads to the American Bridge Co. for building a steel bridge over the Delaware, Lackawanna & Western tracks to replace the present structure at Stiles Crossing.

Spokane, Wash.—The Chicago, Milwaukee & St. Paul has given a contract to the Milwaukee Packet Company at Trinidad, Wash., to carry 400 carloads of cement for the abutments of a bridge across Priest river, 25 miles below Trinidad. The structure will be of steel, and cost $200,000.

Topeka, Kan.—The Atchison, Topeka & Santa Fe has given a contract to Frank Spencer for putting up a number of buildings at a cost of $94,000. The principal building will be a 30-stall roundhouse to cost $62,000.

Winnipeg, Man.—According to reports from Ottawa, application will be made to Parliament by the Canadian Northern, the Canadian Pacific and the Grand Trunk, for joint terminals in this city. A meeting of the companies interested and the National Trans-Continental Commission will be held shortly to arrange the terms of the agreement.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

Brownsville, Hidalgo & Northern.—This company has under consideration the question of further extending its line under construction up the valley of the Rio Grande from Brownsville to Eagle Pass, about 350 miles. Land owners along the route offer large gifts of land.

Buffalo & Susquehanna.—It is said that the Goodyear interests, which control this road, are negotiating for the purchase of the routes, surveys, etc., of the proposed Pittsburg & Northeastern, projected to be built from Pittsburg, Pa., northeast to South Bend, in Armstrong County, 40 miles, and eventually to Binghamton. The route is desired for an entrance into Pittsburg for the Buffalo & Susquehanna. The B. & S. in a few days will ask for bids for building large yards near South Bend, Pa., where 1,000 acres of land were recently bought. The line is now being built from Plumville to Sagamore, where large coal mining operations are under way, and surveys have been completed from Sagamore to South Bend.

Canadian Northern.—In the annual report of this company, the Duluth, Virginia & Rainy Lake, which was the predecessor of the Duluth, Rainy Lake & Winnipeg, is shown on the map as a Canadian Northern line under construction. The Duluth, Rainy Lake & Winnipeg runs from Rainy Junction, Minn., north to Gheen, 57 miles, and work is under way on a northwesterly extension to a connection with the Canadian Northern at Fort Francis, Ont. It is reported that surveys have been made for also extending the road south from Rainy Junction to Duluth, about 60 miles.

Canadian Pacific.—This company has leased the Georgian Bay & Seaboard Railway, now under construction from Victoria Harbor to Peterboro, and is also negotiating for a lease of the Lucknow Railway, under construction from Proton, Ont., to Walkerton.

Work is being pushed in the west from Saskatoon, Sask., east so as to be ready for work on the lines west of that point early next year. Contracts are about being let for the superstructure of a bridge at Saskatoon, and work on the bridge is to be continued throughout the winter. The bridge is to be of concrete and steel and is to be completed by May of next year. Grading on the line from Saskatoon southeast to Strassburg is almost completed. Application is to be made to Parliament for permission to build a line from Saskatoon into the Goose Lake country.

It is said that this company will apply at the next session of Parliament for permission to build a new line from Weyburn west 100 miles to Range 30, west of the second meridian. This will be a further extension of the branch line from Stoughton west to Weyburn. It is also said that application will be made to build a new line from a point on the Moose Jaw branch near Elbow to the present terminus of the Lacombe branch. This would give Moose Jaw direct connection with Edmonton via Lacombe, and indicates that the Moose Jaw branch will be extended into new territory, probably paralleling the Prince Albert branch of the Canadian Northern into Saskatoon, Rostern and Prince Albert districts.

Chicago & Alton.—This company has placed in service 30 miles of double track between Lincoln, Ill., and Springfield, the work having been under way for several months. Work is now under way on the section between Bloomington and Lincoln, about 30 miles.

CORINTH & SHILOH (ELECTRIC).—This company has been incorporated in Mississippi and Tennessee with $250,000 capital to build an electric line from Corinth, Miss., to the National Shiloh Park, Tenn., 22 miles. Bonds have been issued to secure funds to carry out the work. By a special act of Congress the company has been granted permission to operate its cars into Shiloh Park and to put up a hotel there. A. Rubel is President of the company, and W. W. Williams & Co., of Nashville, Tenn., are financing the project.

DELAWARE & EASTERN.—The last spike completing this road was recently driven at East Branch. The road, it is said, is to form a part of the projected Schenectady & Southwestern. (See Construction Record.)

DELAWARE & HUDSON.—An officer writes that contracts have been given to O'Brien & Mullarkey, of Montreal, for building 48½ miles on the Quebec, Montreal & Southern. Maximum grades will be 16 ft. to the mile, and maximum curves 1 deg. The work includes five steel bridges. (Nov. 16, p. 136.)

DULUTH, RAINY LAKE & WINNIPEG.—See Canadian Northern.

GREAT NORTHERN.—The Vancouver, Victoria & Eastern has completed the section of its road from Midway, B. C., west to Molson, about 50 miles, and this section is now ready for operation. The Washington & Great Northern, from Molson to Oroville, Wash., 26 miles, which is a part of the V., V. & E., is also about finished.

GEORGIAN BAY & SEABOARD.—See Canadian Pacific.

HIDALGO & NORTHEASTERN.—Surveys for the proposed extension of this road from its present northern terminus to the Port of Tuxpan will be completed in about six months. The road, which was recently bought by the Mexican Government, is now operated as a part of the Government merger system. The proposed extension is through a rough country involving some difficult engineering.

IDAHO NORTHERN.—This company, of which B. F. O'Neill, President of the National Bank, of Wallace, Idaho, is President, and the Big Bend Water Power Co. announce that they will expend $800,000 in a power plant to develop 30,000 h.p. 28 miles north of Spokane, Wash.; and will build 76 miles of railroad into the Coeur d'Alene mining district at a cost of $1,500,000. E. P. Spalding, Vice-President and General Manager, will have direct supervision of the work.

INDIAN CREEK & POUND RIVER.—This company will build a seven-mile extension of its road from Pound, Va., south into the flats of the Cumberland mountains, where coal and timber fields are to be opened up. The five-mile extension up the north fork of Pound river is well under way. Construction work is to be completed within a few weeks.

KENTUCKY-VIRGINIA.—Announcement from Wise, Va., says that this line will at once be extended to Clintwood, Va., 23 miles. Surveys were completed last year. Address J. A. Boyd, Wise, Va.

LINARES & SAN CARLOS.—This road, which runs from Linares south to San Carlos, state of Tamaulipas, Mex., is to be extended to a point on the gulf coast, either to Barra de Sandoval or to Soto la Morina.

LOUISIANA CENTRAL.—See New Orleans, Crowley & Western.

LUCKNOW RAILWAY.—See Canadian Pacific.

MACKENZIE-MANN SYSTEM.—Application is to be made by Mackenzie & Mann to Parliament for franchises to build extensions and new branch lines on the Canadian Northern and the other roads of this system as follows: On the Canadian Northern Ontario Railway Co.: Washago west to Lake Huron near Kincardine; Arnprier south to St. Lawrence river between Kingston and Brockville; Pembroke southwest to Lake Ontario between Toronto and Belleville; Toronto-Ottawa line northwest to Georgian Bay, near Collingwood or Owen Sound; Toronto-Ottawa line west through or near Toronto, Hamilton and London to Windsor, with branches to St. Thomas and Sarnia, and a branch or loop north of Toronto; Niagara river northwest through or near Hamilton to Lake Huron near Goderich; Lake Erie west of Port Colborne, north through or near Brantford or Berlin to Georgian Bay; from a point near Washage to the Georgian Bay east of Collingwood; Montreal-Ottawa line north of Montreal, westerly to connect with the authorized line in the County of Leeds or Lanark.

In the Northwest the following branches and extensions of the Canadian Northern are asked for: From the line at or near Humbolt in the province of Saskatchewan, in a southwest direction to Calgary; on the Qu'Appelle, Long Lake & Saskatchewan Railroad, between Craik and Baldworth.

Also an extension of its line from a point on its line at Humbolt northwest to Township 43; from a point on the railroad at South Battleford in a westerly direction to a point in Township 44, Range 27; from a point on its line at North Battleford in a northwesterly direction to a point in Township 59, Range 1; from its line at Strathcona south to Calgary; from Regina southwest to a point on the International boundary; a point at or near Saskatoon southwest to a point on the South Saskatoon river; a point on its authorized line at or near Edmonton, thence by the most feasible route to a point on the Pacific coast; a point on its authorized line near the forks of the Athabasca and McLeod rivers southwest to the head waters of the McLeod river; from Battleford westerly a distance of 100 miles.

MANITOBA RADIAL.—An application has been made by Arthur Wagner, of Ottawa, representing Winnipeg capitalists, to incorporate a company to build a line from Winnipeg northwest to Lake Manitoba, with a number of branches.

MEXICAN INTERNATIONAL.—It is said that this company's proposed branch from Allende to a point on the Rio Grande opposite Delrio, Tex., will be built next year. Surveys have been finished and submitted to the Mexican Government for approval. The line will be 60 miles long. It will connect at Delrio by means of a bridge across the Rio Grande river with the Southern Pacific.

The Government System of railroads is planning to secure an entrance into the city of Guadalajara by building an extension of this road from Durango south to that city. Surveys have been under way since June of last year. It is said that the final locating work has been completed to within a short distance of Guadalajara and will be completed by spring. The proposed line will have easier grades than the Mexican Central, and will make a short and direct route from the United States border to Guadalajara. It is hoped to have the new line completed before the new line of the Southern Pacific reaches Guadalajara.

MILWAUKEE & FOX RIVER (ELECTRIC).—Incorporated in Wisconsin with $25,000 capital by J. M. Seaman, of Sheboygan; G. Bricknauer, J. B. Connell, H. W. Wilson, F. Phillips, A. J. Pullen and others. The company proposes to build an electric line from Cedarburg, Ozaukee County, on the Chicago, Milwaukee & St. Paul, north, following the lines of the Chicago & North-Western and the St. Paul roads through Sheboygan and Calumet counties to Chilton; thence to Kaukauna and Appleton, in Outagamie County, about 80 miles. A branch is also to be built southwest from Chilton along the east shore of Lake Winnebago to Fond du Lac, 30 miles, where connection will be made with the Milwaukee Northern.

MINERAL BELT.—This company was recently to hold a meeting at Florence, Ala., to authorize an issue of bonds to secure funds for building its proposed line from Florence to Manning, Tenn., about 15 miles. T. H. Allen of Florence is interested.

MISSOURI, KANSAS & TEXAS.—The line from Trinity, Tex., to Colmesneil, 75 miles, will be extended northeast to Shreveport, La., 125 miles, where a connection is to be made with the eastern division of the road. Surveys are now being made. It is also planned to build west from Trinity to a connection with the Austin & Smithville division at Granger, 200 miles.

NEW ORLEANS, CROWLEY & WESTERN.—Surveys, it is said, are being made by this company for a new route into New Orleans. It is believed that this company, projected from New Orleans to a connection with the M., K. & T. in Texas, and the Louisiana Central, under construction from Monroe, La., south to New Iberia, were organized for the purpose of surveying a route into New Orleans, and possibly building all or a part of a line into that city, with the intention of selling out to the Kansas City Southern. The Louisiana Central is said now to have abandoned its work, which seems to mean that the New Orleans, Crowley & Western has won in its efforts to have the Kansas City Southern adopt its route into New Orleans in preference to that offered by the Louisiana Central.

NEW YORK CENTRAL & HUDSON RIVER.—This company is planning a two-track subway under West Fifty-third street, New York City, to connect the present Park avenue tunnel with the proposed subway under Eleventh avenue. Such a connection, if built, would allow some Hudson division trains to be run by this route from Spuyten Duyvil to Grand Central Station and so relieve the Park avenue tunnel.

OKLAHOMA, TEXAS & GULF.—This company is being organized with headquarters at Clarendon, Texas, to build a line from Clarendon, Texas, on the Fort Worth & Denver City, east through Oklahoma and Indian Territory to Nashville, Ark., on the Arkansas & Louisiana, about 350 miles. The promoters include F. B. Wildman, of Blair, Okla.; E. A. Williams, of Roosevelt, Okla.; C. A. Huber, of Weatherford, Okla.; R. K. Wooten, of Chickasha, Ind. T.; J. W. Buchanan, of Van Buren, Ark.; R. Burge, Felix P. Both and L. B. Comer, all of Fort Worth. It is said that this is a Rock Island-Frisco project.

ORFORD MOUNTAIN.—This company, operating 50 miles of road from Eastman, Que., has made application to Parliament for an extension of time to complete an extension of its Bolton branch 10 miles. Grading has been completed for six miles.

PENNSYLVANIA.—Improvements on the Pittsburg division of this road, between Altoona and Pittsburg, to cost about $1,750,000, were

recently authorized by the Board. At Greensburg the improvements include cutting out the tunnel and the construction of overhead bridges at street crossings, so as to make a four-track line.

Pennsylvania Roads (Electric).—A new syndicate is reported formed to build an electric line from Pittsburg down the Ohio river on the west side, with a branch up the Beaver Valley to Newcastle. This line will compete with the Beaver Valley system of the Philadelphia company. Connection is proposed at Newcastle with the Sharon & Newcastle electric line. The names of the promoters are not given.

Pittsburg & Northeastern.—See Buffalo & Susquehanna.

Quebec, Montreal & Southern.—See Delaware & Hudson.

St. Joseph, Savannah & Northern.—Incorporated in Missouri with $300,000 capital, and office at St. Joseph, to build a line from St. Joseph north to Savannah, in Andrew County, about 15 miles. The incorporators include T. B. Campbell, M. Tootle, F. J. Wheeler and others, of St. Joseph.

San Francisco, Idaho & Montana.—This company, which proposes to build a line from Butte, Montana, to San Francisco with a branch from Caldwell to Winnemucca, Nev., has completed surveys from Caldwell to Homedale, Idaho, 16 miles, and has surveys under way from the latter point to Winnemucca, 180 miles. It is expected to start construction work early next spring. Donald Grant, Faribault, Minn., is President.

Schenectady & Southwestern.—See Delaware & Eastern.

Sierra Pacific.—A holding company, the Sierra Pacific Company, has been incorporated in California with a capital stock of $200,000. This road is to be built from Globe, Tulare County, Cal., southwest to Port Hanford, 193 miles from Globe, with branches aggregating 280 miles. The railroad company's first block of $1,000,000 of 6 per cent. preferred debenture stock was greatly over-subscribed, and another million has since been taken up. The company is now about to sell 6 per cent. 40-year, first mortgage gold bonds to complete the road. The road will be laid with 70-lb. and 80-lb. rails, and will have pressed steel passenger cars electric lighted. Several new towns will be created by this company, at one of which, Ellisvale, shops will probably be built. The company intends to build a line from Globe, Cal., the proposed eastern terminus, to a point in Nevada, where connection will be made with the Western Pacific. Surveys have been made through the Sierra Nevada mountain range and a favorable route selected. It is proposed to build also to Los Angeles, the capital stock of the road to be increased. The President of the company says that English capital has been interested in this addition to the project, and that the company will issue 30-year bonds to cover this addition, most of these bonds being already negotiated for. (Oct. 12, p. 99.)

Springfield, Wilmington & Cincinnati (Electric).—Incorporated in Ohio, with $3,000,000 capital stock, by George F. Parmalee, Frederick Gargenhire, William C. Morton, Gustav Von Den Steinen, Richard Ingliff, Julian W. Tyler and Horace Andrews. The company proposes to build an electric line connecting Springfield, Ohio, with Cincinnati, traversing the counties of Clark, Greene, Clinton, Warren and Hamilton, with a branch from the main line, in Greene County, to Xenia. The headquarters of the company are at Springfield.

Sumpter & Choctaw.—This company, which is owned by the Allison Lumber Company, of Bellamy, Ala., and operates a line 17 miles long from that place to Temopolis, has extended its road south to Witfield. The company is planning to extend the road an additional five miles south into Choctaw County.

Vancouver, Victoria & Eastern.—See Great Northern.

Wabash.—An officer writes regarding the double-track work on this road, that the company expects to build about 30 miles of track each year until the entire line is double-tracked between St. Louis and Chicago. Plans are also being made to double-track portions of the Detroit division aggregating about 30 miles, and to straighten the line on the Moberly division.

Washington & Great Northern.—See Vancouver, Victoria & Eastern.

Yankton & Southern.—Incorporation has been asked for by this company in South Dakota with $100,000 capital to build a line from Yankton, S. Dak., south to Galveston, Tex. The offices of the company are to be at Yankton and at Cincinnati, Ohio. The incorporators include Robert J. Gamble and W. J. Frantle, of Yankton; J. Lowman, T. R. Paxton, F. Hill, W. C. Proctor and others, of Cincinnati, Ohio.

RAILROAD CORPORATION NEWS.

Baltimore & Ohio.—Gross earnings for the month of October, 1906, were $7,321,458, an increase of $467,666; net earnings $2,635,771, an increase of $93,790.

Chattanooga (Tenn.) Railways.—The first quarterly dividend of 1¼ per cent. on the $1,000,000 5 per cent. preferred stock has been declared, payable December 1 to shareholders of record on November 15. The company was organized last April as a consolidation of all the street railways in Chattanooga.

Chicago, Milwaukee & St. Paul.—According to press despatches from Chicago, this company has incorporated in New Jersey an express company with $30,000,000 capital stock, which is to operate over the C., M. & St. P. lines after the present contract with the American Express Co. expires on January 1, 1908.

Cleveland, Cincinnati, Chicago & St. Louis.—The $10,000,000 new stock authorized last October is to be offered on December 15 at 90 to the holders of the present $40,000,000 outstanding common and $10,000,000 outstanding preferred stock to the extent of 20 per cent. of their holdings; the privilege of subscribing terminates on January 15.

Great Northern.—An official announcement was made on November 22, stating that the Board of Directors had authorized the Lake Superior Company to transfer the iron ore properties, which have been leased to the United States Steel Corporation, to Lewis W. Hill, James N. Hill, and Walter J. Hill, Trustees, to be held by them for the benefit of the stockholders of the Great Northern. The beneficial interest will be divided into 1,500,000 shares, certificates of which will be distributed at the rate of one share for every share held to holders of the $150,000,000 Great Northern stock. The profits accruing from the rental of the ore lands are to be distributed at least once a year by the trustees to the holders of these certificates. (Oct. 12, p. 100.)

Interborough Rapid Transit.—The New York Stock Exchange has listed $4,800,000 capital stock of the Manhattan Railway, making the total outstanding $60,000,000, which is the amount authorized. The Manhattan Railway owns all the elevated railroads in the Boroughs of Manhattan and the Bronx, New York City, 38 miles, and is leased to the Interborough Rapid Transit, which guarantees 7 per cent. per year on the stock. It is understood that the proceeds from the sale of the recent issue are to be used for improvements.

Kansas City Southern.—Gross earnings for October, 1906, were $778,917, an increase of $146,646; net earnings $328,284, an increase of $166,118. Gross earnings for the four months ended October 31, 1906, were $2,843,868, an increase of $564,118; net earnings $1,050,042, an increase of $555,480.

Manhattan Railway.—See Interborough Rapid Transit.

New York & Port Chester (Electric).—See New York, Westchester & Boston.

New York, Westchester & Boston (Electric).—According to New York newspapers, control of this company has been bought by Oakleigh Thorne and Marsden J. Perry, who, it is said, also control the New York & Port Chester. The routes of the two lines are parallel and close together and the companies have been opposing each other for some time. The New York, Westchester & Boston is to run ultimately from 129th street and the Harlem river, New York City, north and east to White Plains. Work has been under way from 177th street north. The New York & Port Chester has franchises for a four-track line through the Borough of the Bronx, New York City, and has other franchises in towns along its route which, as stated above, parallels the New York, Westchester & Boston. Some construction work has also been done in connection with this line.

Pennsylvania Company.—The New York Stock Exchange has listed $20,000,000 4 per cent. 15-25 year collateral trust bonds, issued by the Pennsylvania Company and guaranteed by the Pennsylvania Railroad. The collateral was originally secured on $10,000,000 Baltimore & Ohio common stock, $14,000,000 Pittsburg, Cincinnati, Chicago & St. Louis common stock, and $4,000,000 Vandalia stock. Acting on an option held under the deed of trust, the company on July 17, 1906, withdrew the Baltimore & Ohio common stock and substituted other collateral, so that the bonds are now secured by the following stock:

	Par.	Appraised value.
Pitts., Cin., Chic. & St. Louis, common stock	$14,000,000	$11,340,000
Vandalia, stock	4,000,000	3,400,000
Bald Eagle Valley, stock	765,000	1,912,500
Cumberland Valley, common stock	975,800	2,146,760
Cleveland & Pittsburg, betterment stock	2,216,500	2,305,160
West Jersey & Seashore, common stock	3,660,100	4,538,524
Philadelphia, Washington & Baltimore, stock	500,000	500,000
Total	$26,117,400	$26,142,944

Gross earnings for the year ended June 30, 1906, of the Pennsylvania Company, which operates the Northwest system of the Pennsylvania Lines West, were $42,083,766; net earnings $11,535,973. The net income was $5,711,090, out of which were paid $1,656,623 for sinking funds, an annual dividend of 5 per cent. in December, 1905, on $40,000,000 stock, and a semi-annual dividend in June, 1906, of 3 per cent. on $60,000,000 stock. The surplus for the year was $254,466.